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U. S. A R M Y  
TRANSPORTATION RESEARCH COMMAND  
FORT EUSTIS, VIRGINIA

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TRECOM TECHNICAL REPORT 63-10

Automatic Light Aircraft Readiness Monitor  
Project ALARM

VOLUME III

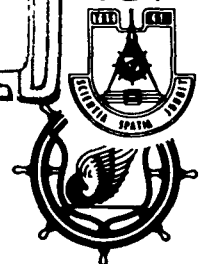
Project 9R89-02-015-16  
Contract DA 44-177-TC-641

January 1963

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**Task 1D141812D18416**  
**(Formerly Task 9R89-02-015-16)**  
**Contract DA 44-177-TC-641**  
**TRECOM Technical Report 63-10**  
**January 1963**

**Project ALARM**  
**AUTOMATIC LIGHT AIRCRAFT READINESS MONITOR**  
**Phase II Test Program**

**VOLUME III**  
**ADDENDUM - REINSTALLATION**

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## FOREWORD

This report, Volume III of TRECOM Technical Report 63-10, dated January 1963, covers the reinstallation of the modified ALARM System in the JHU1 S/N 576103 Bell Helicopter.

The reinstallation of the modified ALARM System was undertaken on May 21, 1962, upon receipt of the aircraft after overhaul. Completion of this phase was accomplished August 2, 1962, when the aircraft and the ALARM System were delivered to USATRECOM, Fort Eustis, Virginia, for evaluation.

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### SUMMARY

The following discussions include the installation procedures, calibration data, and results of the modified ALARM System Installation.

This phase is not intended as a test program, but is intended only to verify the modified ALARM System's ability to repeat the findings determined in the test program phase (TRECOM Report 63-10, Vol. I and Vol. II).

Data accumulated during this phase are included. Comparison of data from the test program will not necessarily concur, inasmuch as the aircraft airframe was modified and new transmission and gear boxes were installed during the aircraft overhaul. In addition, the tail vibration sensor was relocated.

The modified ALARM System virtually eliminates temperature drift, and the results of this phase compare favorably with the test program results.

### CONCLUSIONS

It is concluded that the ALARM System, as modified and reinstalled, has been proven functionally operable. When permissible, known malfunctions introduced in the specific monitored areas of the aircraft are easily detected by the modified ALARM System.

It is further concluded that additional testing must be accomplished before operating limits or detection levels, as determined herein, can in any way be considered final.

It is also concluded that the temperature compensation technique employed in the modified ALARM System is feasible and practicable.

### RECOMMENDATIONS

It is recommended that additional test programs be conducted to further substantiate the results obtained thus far. It is essential, particularly in the area of vibration and temperature, to obtain data from various type aircraft in order that the detection level or limit may be determined. These tests should include several aircraft of each type to give a good representation of each type.

It is also recommended that additional channels as suggested by this report be investigated and tested for incorporation in the ALARM System.

## MODIFICATION

### GENERAL

Modification of the Alarm System was begun in September of 1961 and completed in December of 1961. The Aircraft (JHU-1 S/N 576103) was released to New Cumberland General Depot, New Cumberland, Pa., Dec. 1, 1961, for overhaul. The aircraft was returned to the York Division, and reinstallation of the modified Alarm System was initiated May 31, 1962.

The modifications of the Alarm System were both mechanical and electrical. The mechanical effort consisted of the following modifications:

### LIQUID LEVEL CHANNELS (CHANNELS 6, 7, 8, 9)

Changes were made in the design of the thermistor mounts to allow the leads to extend from the side of the thermistor mount rather than the end. This design change reduced the over-all length due to the protruding end-leads. The protruding lengths generated a problem at the 42<sup>0</sup> gear box in particular.

The control cable for the tail rotor pitch was aligned directly over the thermistor mounts and the leads were subjected to interference from the cable. The new design permits Teflon strips to be placed at the top of the thermistor mounts to prevent the possibility of the cable fraying should interference occur.

### FLAT CONDUCTOR CABLE

Flat Conductor Cable was used experimentally in the original installation. Electrically, no problems were incurred; but securing this type cable was a problem. Satisfactory commercial cable connectors were not available, necessitating a special design effort by the York Division. These specially designed connectors proved fully acceptable for the application. The broad width of the cable was a problem in routing, and security was almost an impossibility. Some deterioration of the cable insulation occurred due to chemical reaction with fuel and oil. However, this deterioration did not affect the electrical qualities.

The decision to use standard, twisted, single-strand conductors was prompted by the preceding conditions.

### INTERLOCK CONSTRUCTION AND LOCATION (CHANNELS 1, 2, 3, 4, 5)

Interlock elimination was a mutual decision between TRECOM and the York Division. It was concurred that the crew door, cargo door, and antenna-cover interlocks would be eliminated. This change resulted from determinations derived from the test program.

In addition, a change was made in the interlock assembly due to problems encountered during the test program. The primary problem was the bending of the actuator arms. The original requirement that a minimum or no alteration be made in the aircraft frame did not permit the skin of the aircraft to be cut. This decision prevented an adequate design.

A more lenient outlook on the installation modification permitted adequate design. A standard switch and roller actuator arm were used throughout, eliminating the requirement for special actuator arms for each installation. This was accomplished by cutting a small square hole at each location to allow the actuator roller to protrude through the hole. The switch mounting bracket was used as a reinforcement and mounted directly behind the cutout. Each switch mounting is adjustable to compensate for normal wear and tolerances.

#### FILTER BYPASS (CHANNELS 16, 17, 18)

The test program indicated that the design of the switch-lead arrangement was not adequate for this application. A conference was held with the filter manufacturer and a decision effected to use a smaller magnetic glass reed switch. The small switch allowed the device to be encapsulated and still have sufficient lead depth in the potting compound to prevent the lead breakage that had occurred previously.

#### PRESSURE RELIEF VALVE, TRANSMISSION (CHANNEL 19)

A modification of the original pressure relief valve was purchased from the aircraft manufacturer to indicate valve bypass action. During the test program, it was discovered this valve did not regulate. The valve spring would bind against the valve stem, preventing valve movement.

The York Division then designed a relief valve to eliminate the binding problem. Since redesign was required, two additional considerations were undertaken. The first was to increase the valve travel, and the second to have the travel as nearly linear as possible. This was accomplished by increasing the over-all length and using narrow slots in place of the large diameter holes for the relief of the oil pressure.

#### CHIP DETECTOR TRANSMISSION (CHANNEL 11)

The original chip detector used a spacing of 0.100-inch gap. The gap was reduced to 0.060 inch for the modification. This was done to provide a uniform spacing, since both gear boxes and the engine were 0.060 inch. The smaller gap will allow a smaller chip and/or accumulation of chips to give an indication.

Electrical modifications made to the ALARM System prior to reinstallation consisted of the following items:

#### TRANSMISSION VIBRATION TOP AND BASE (CHANNELS 21, 22)

A 10-second delay circuit was added to allow for transients and fluctuations of short duration in the vibration amplitude. This would include fluctuation due to extreme flight attitudes and wind gusts. Separate dynamic and in-flight adjustments were also incorporated. The initial adjustment required both dynamic and in-flight variation with one adjustment. This did not give enough variation in one limit without giving too much variation in the other limit.

#### ENGINE VIBRATION, FORE AND AFT (CHANNELS 23, 24)

The 10-second delay circuit and the separate in-flight and dynamic adjustment were incorporated as in the previous discussion. The low frequency bandpass was also narrowed to eliminate the effect of tail vibration on the engine channels.

#### TAIL AND LOW FREQUENCY VIBRATION (CHANNELS 25, 26)

Incorporated the 10-second delay circuit and the separate in-flight and dynamic adjustments.

#### ENGINE SPEED (CHANNEL 28)

Incorporated a lock-in circuit and a reset button. The lock-in enabled the circuit to hold the overspeed indication on until reset manually by means of the push-button reset. The aircraft can be shut down after an overspeed is indicated, and the indicator will remain illuminated until the reset button is actuated.

An investigation for a better design to overcome temperature drift was undertaken. The result was a feasible design and was presented to TRECOM for approval. Due to financial and time factor considerations, the decision was made not to incorporate further temperature correction.

## ALARM SYSTEM CHANNEL ASSIGNMENT

CHANNEL NO.	NOMENCLATURE
1	Forward Door Interlocks
2	Left Aft Door Interlocks
3	Right Aft Door Interlocks
4	Filler Cap Security
5	Landing & Search Light Security
6	Transmission Oil Level
7	Engine Oil Level
8	90 <sup>0</sup> Gear Box Oil Level
9	42 <sup>0</sup> Gear Box Oil Level
10	Spare
11	Transmission Chip Detector
12	Accessory Gear Box Chip Detector
13	42 <sup>0</sup> Gear Box Chip Detector
14	90 <sup>0</sup> Gear Box Chip Detector
15	Spare
16	Transmission Oil Filter
17	Fuel Filter
18	Engine Oil Filter
19	Transmission Pressure Relief Valve
20	Spare
21	Transmission Top Vibration
22	Transmission Base Vibration
23	Aft Engine Vibration
24	Forward Engine Vibration
25	Tail Vibration
26	Low Frequency Mast Vibration
27	Spare
28	Engine Speed
29	Excess Engine Oil Flow

CHANNEL NO.

NOMENCLATURE

30	Spare
31	Swash Plate Bearing Temperature
32	Transmission Input Quill Temperature
33	Forward Shaft Hanger Bearing Temperature
34	Mid Shaft Hanger Bearing Temperature
35	Aft Shaft Hanger Bearing Temperature
36	42 <sup>0</sup> Gear Box Temperature
37	90 <sup>0</sup> Gear Box Temperature
38	Spare
39	Spare
40	Spare

## INSTALLATION

Installation of the modified ALARM System was begun at the York Division on May 22, 1962, after receipt of the aircraft from New Cumberland General Depot.

All sensors were calibrated upon completion of the modification to the electrical circuitry of the ALARM System. No calibration of sensors was accomplished with sensors already installed on the aircraft. The ALARM System was calibrated after installation in the test bed aircraft.

Mechanical modifications were undertaken first. It had been planned to use the original mounting brackets for switches and some of the original wiring. During overhaul, however, all ALARM System components were removed and many were never found. This required new brackets and wiring. Wherever possible, standard components were used. TRECOM furnished an Army helicopter mechanic to assure all work conformed to standard military practice.

### CHANNELS 1-5

Installation of interlocks consisted of mounting the brackets and switches at appropriate locations. No major modification was undertaken. A small (3/8 inch square) hole was cut into the aircraft skin for the switch actuator arm for the forward, left and right rear interlocks. The engine cowling used a different type switch, since it was not possible to go through the aircraft skin at this point without making a lead that required a disconnect to remove the cowling.

The filler cap on the transmission required a new mounting clamp and ring. After overhaul, the transmission in this aircraft had a larger diameter boss for the cap. This placed the switch beyond the old ring, thus requiring a new ring.

The landing and searchlight switches and brackets had been removed during overhaul, thus requiring a new installation. The original installation used long, fragile, actuator arms which were subject to bending and a misalignment. This problem was eliminated by using a standard roller switch with a special actuating pad.

### CHANNELS 6, 7, 8, 9

Installation of the liquid level channels consisted of removing the sight glasses and replacing with the sight glass containing the thermistor mounts manufactured by Bendix York. The exception was the engine oil level which was built into the engine oil reservoir originally and was still intact. However, thermistor mounts were used in this installation.

### CHANNELS 11, 12, 13, 14

The installation of the chip detectors consisted of replacing the original magnetic plugs with electrical chip detectors with the same physical dimensions. One exception was the transmission chip detector, in which the gap was reduced from 0.100 inch to 0.060 inch.

#### CHANNELS 16, 17, 18

Installation of the filters consisted of a direct exchange of the original filters with the ALARM-design filters. When the aircraft engine oil filter was removed from the aircraft for replacement with the ALARM System filter, a large number of metallic chips were found in the oil filter screen. The engine manufacturer's representative was contacted and an inspection of the system was made. The investigation revealed that the filter apparently had not been cleaned prior to installation on this engine.

#### CHANNEL 19

Installation of the transmission pressure relief valve was also a direct exchange of the original PRV for the Bendix York PRV.

#### CHANNELS 21, 22, 23, 24, 25, 26

Installation of the vibration sensors was as in the test program. Sensors were mounted as closely as possible to the monitored component. This was to eliminate as much as possible any effects from the addition of the sensor or additional resonance from the mounting. No changes were made in location or mounting of the sensors.

#### CHANNEL 28

Engine speed installation was accomplished by electrical connection to the tachometer output at the front of the console. The input for this circuit is dependent upon the aircraft tachometer output. No separate sensor was used for this channel.

#### CHANNEL 29

Installation of the engine oil flow sensor was identical to the test program. New tubing was required, however, even though the aircraft frame and reservoir was the same. The tubing used in the test program did not fit; apparently due to a shift in the placement of the reservoir and the connecting oil lines. The same sensor used in the test program was reinstalled.

#### CHANNELS 31-37

Installation of the temperature sensors was basically the same as the test program. Two changes were made. The main mast bearing sensor was relocated on the transmission input quill bearing. The ambient temperature sensor was changed from the "Hell Hole" to the oil cooler fan housing. This latter change was to obtain a more realistic ambient temperature. The "Hell Hole" is also the exhaust area for the oil cooler fan and, therefore, was usually warmer than the ambient. Since the oil cooler fan housing was isolated and the ambient air was drawn around and through this housing, it was felt this would be a location more indicative of the true ambient temperature. Adhesive-backed thermal ribbons were used in all temperature sensing locations.

### INSTALLATION PROBLEM AREAS

No mechanical problems of any consequence were encountered during the installation of the ALARM System. Electrical problems were encountered in the circuitry during the checkout procedure but are discussed under the heading in which they occurred. These problems included adjustment limits on circuits, loose connections and wiring errors.

## FUNCTIONAL CHECK

The functional check of the ALARM System was performed to assure that each sensor and circuit was operating. No attempt was made to measure any limits, voltages, currents, etc., at this time. The sole purpose of this check was to determine whether the ALARM display panel indicated a malfunction under artificial excitation. The vibration, speed, and flow channels were not checked during this phase. A controlled vibration and volume flow check would have been too time-consuming. The vibration speed and flow channels were checked during the operational phase.

### CHANNELS 1-5

The functional check for the interlocks consisted of actuating each switch individually to determine operation of the electrical circuit.

### CHANNELS 6-9

Liquid level channels were checked functionally by overfilling and draining the reservoirs for each component.

### CHANNELS 11-14

The functional check of the electrical chip detectors was performed by "shorting" the gap in each detector. This was accomplished by grounding the shell of the detector to the aircraft-ground and holding a conductor between the shell and the center contact. These detectors use a one-wire conductor requiring the shell to be grounded to the aircraft to complete the circuit.

### CHANNELS 16-18

Functional operation of the filters was checked by using a hand-held magnet against the housing in which the magnetic reed switch is imbedded. A strong magnet and a "hit and miss" method was used to determine the exact location of the switch.

### CHANNEL 19

The transmission pressure relief valve was checked by switch actuation only.

### CHANNELS 21-29

These channels are the vibration, speed, and flow channels and were not checked in this phase.

### CHANNELS 31-37

Operation of the temperature channels was checked by using the calibrated potentiometer. This checked only the circuitry and not the sensors. The sensors were checked by measuring the resistance at the ALARM display/control plug-in terminal.

### BATTERY TEST

A 6-ampere load was put through this circuit to determine that the circuit breaker would trip as required.

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## OPERATIONAL CHECK

The operational check was performed to prove the ALARM System's ability to indicate GO and NO GO conditions. The static mode check of liquid levels and interlocks by necessity was conducted when the aircraft was nonoperational.

### CHANNELS 1-5

The operational check for these channels was performed by actual operation of each access door cowling or filler cap. The door cowlings which are connected in series were checked individually and collectively. This check revealed the right rear access door was wired in error. The filler caps were also checked individually and collectively. This check also revealed the hydraulic filler cap had been wired in error.

### CHANNELS 6-9

The liquid level check was considered complete with the functional check, since the level had been raised and lowered by addition and removal of the oil.

### CHANNELS 11-14

No operational check was made on these channels since the chip detector was not accessible while installed, and it was deemed advisable not to add ferrous particles to the systems.

During the operational check, it was discovered the 90<sup>0</sup> gear box gave a continuous NO GO indication. A check of the complete circuit gave no indication of a wiring error or other malfunction. The indication was finally traced to an installation error. A new chip detector had been installed and, since the detectors are interchangeable, the same self-closing mechanism was used. The original mechanism was metallic and shorted the chip detector. Replacing the self-closing mechanism with the plastic type as supplied by the manufacturer corrected this condition.

### CHANNELS 16-18

Operational check of the filter channels consisted of a total or 100% blockage of each filter. This check was accomplished by removing the filter screen portion of filter and substituting plugs supplied by the filter manufacturer. No attempt was made to determine at what percentage-flow the bypass valve actuated the circuit.

### CHANNEL 19

Some difficulty was encountered on the transmission pressure relief valve (PRV) during this portion of the program. The redesigned valve had never been installed prior to this time and the behavior of the valve was unknown. The initial installation indicated the relief valve spring was not strong enough. With full adjustment, the maximum pressure available was 43 psi indicated on the instrument panel. A

new spring was designed and manufactured. This new design then created a problem, in that it was too strong and a minimum pressure of 70 psi indicated. A compromise spring evolved and was installed. The PRV as installed regulated pressure to  $50 \pm 5$  psi and the valve was passing with a 5/16-inch travel indicated. The switch actuation was then adjusted to operate with an additional 1/16-inch travel. No malfunction or blocked jet test was permitted and, therefore, no information is available as to how much travel is indicative of a problem area.

#### CHANNELS 21-26

Operational checks of the vibration channels were conducted by lowering and raising the detection level setting. This was indicative that the circuit was working over the intended range and that the aircraft vibration for each channel was within that range. No attempt was made to introduce a known malfunction for the operational check.

The initial trial of the ALARM System in this phase disclosed that the vibration channels 23 (Aft Engine) and 24 (Fwd Engine) failed self-check. An examination of these circuits revealed that a transistor was not functioning. This was the first electrical component failure in the ALARM System since the breadboard was built.

It was also determined at this phase that two input connectors had been plugged into the ALARM System at 180° from normal. It was felt this mistake may have been a contributing factor to the preceding and subsequent electrical failures.

#### CHANNEL 28

Engine speed operational check consisted of setting the limit at 6700 rpm, reducing speed, resetting the circuit, and increasing the speed to 6700 rpm to determine the circuit response.

#### CHANNEL 29

The operational check of the oil flow channel was accomplished by opening a drain valve in the engine oil return line. No attempt was made, at this time, to measure the flow rate required to actuate the circuit.

#### CHANNELS 31-37

No attempt was made to introduce overheat conditions in any of the temperature channels. The operational check was made by using a calibrated potentiometer and introducing a variable resistance into the temperature sensing circuit. The thermal ribbons were not in the circuit at this time. Resistance readings were taken of each thermal ribbon at the ALARM control/display box to assure the continuity of the circuit. The calibrated potentiometer allowed the ambient and each channel resistance to be varied to either a higher or lower representative temperature, together or separately.

## CALIBRATION PROCEDURES

### GENERAL

Detection or indication levels for the ALARM System have been predicated upon the history of the Test Program (Phase II), together with the characteristics exhibited by the aircraft during the Reinstallation Program. The phrase "Calibration Procedure", referenced in this section, shall be defined as "The techniques employed to measure the detection or indication level of a particular channel". The "Calibration Procedure" does not imply any determination or assignment of the detection or indication parameters.

The calibrated channels are those pertaining to Vibration, Temperature, Flow, and Engine Speed. All other channels are classed as interlocks or continuity channels and require no adjustment; thus no calibration is necessary.

### SYSTEM TEST AND CALIBRATION PROCEDURE

#### Vibration Channels

All channels (Xmsn, Eng., Tail, Low Freq.) are adjusted in a sequence of three steps for final operation.

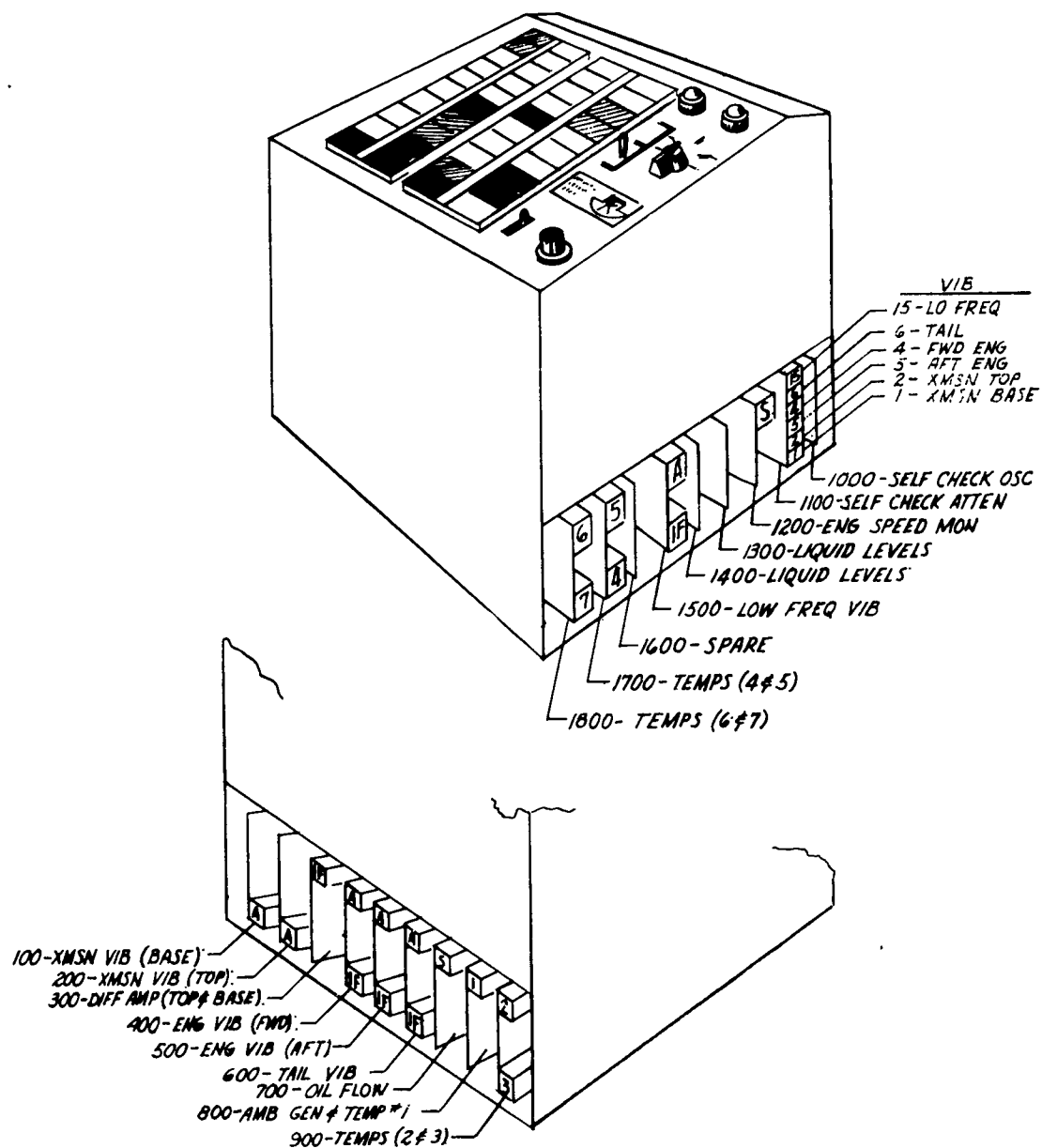
1. Dynamic Mode Adjustment - Performed under ground run conditions, 6400 rpm. Adjust trimpot labeled (A) on Figure 1 for desired dynamic operating point (clockwise until indication is observed on applicable channel, then counterclockwise until indicator is out; finally 1/2 to 1 full turn counterclockwise to eliminate normal variation indication). This adjustment is the input signal attenuator. It should be noted that since a 10-second channel delay is incorporated in all vibration channels, this and the In Flight adjustment (Paragraph 2) will have to be done incrementally when adjusting to turn indicator on.

2. In Flight Mode Adjustment - Performed under S/L (straight and level) flight attitude, 70-80 knots IAS (indicated air speed). Adjust as above using trimpot labeled (IF) on Figure 1 for the applicable channel. This adjustment is the differential amplitude detection level or reference voltage.

3. Self-Check Adjustment - Adjust applicable trimpot on self-check attenuator MB1100. (Clockwise to turn indicator on, then counterclockwise to turn light off, counting number of turns; then set midway for optimum operation). No delay is involved on self-check actuation.

#### Temperature Channels

Channels are set for desired operation. The levels are indicated in Table 1.



#### ADJUSTMENT CODE

A. - INPUT SIGNAL ATTENUATOR - DYNAMIC MODE ADJ. (CW TO TURN "ON") BOTH HAVE  
 I.F. - DETECTION LEVEL ADJ. - IN FLIGHT MODE ADJ. (CW TO TURN "ON") 10 SEC. DELAY  
 S. - SENSITIVITY ADJ.  
 TEMP. BDS. (1 THRU 7) - SENSING TEMP. ADJ., CHANNELS 31 THRU 37, RESP.  
 SC ATTN. BD. (1, 2, 5, 4, 6, 15) - SC AMPLITUDE ADJ., 100, 200, 500, 400, 600, 1500 BDS RESPECTIVELY  
 TEMP. & OIL FLOW - TURN CW TO TURN ALARM INDICATION "OFF"

CPI/1515

FIGURE 1. INTERNAL ADJUSTMENTS, ALARM CONTROL DISPLAY UNIT

TABLE 1. TEMPERATURE CHANNELS, DETECTION LEVELS

Swashplate Brg. Temp.	+45°C Limit at 20°C
Xmsn Input Quill	+80°C Limit at 20°C
Fwd Shaft Hanger Brg.	+100°C Limit at 20°C
Mid Shaft Hanger Brg.	+100°C Limit at 20°C
Aft Shaft Hanger Brg.	+100°C Limit at 20°C
42° Gear Box Temp.	+95°C Limit at 20°C
90° Gear Box Temp.	+65°C Limit at 20°C

A 2-degree centigrade change in ambient causes a 1-degree centigrade change in the limit temperature.

These limits are believed to be optimum but if a change should be desired for any reason, adjustment procedure is as follows:

1. Connect calibrated 10 turn-pots to sensing, ambient, and common connector inputs on J1 thru J6 for the appropriate channel.
2. With applied system power, adjust trimpots Nos. 1, 2, 3, 4, 5, 6, or 7 as desired on MB800, 900, 1700, or 1800 counterclockwise to bring temperature limit down or clockwise to raise the limit. Adjust calibrated pots to determine limit setting at +20°C ambient.

#### Engine Oil Flow and Engine Speed

Adjust trimpots labeled (S) on MB700 and MB1200, respectively, for desired sensitivity.

#### VIBRATION CALIBRATION SETTINGS

TABLE 2. VIBRATION CALIBRATION SETTINGS

Channel	Vibration	Frequency	Dynamic Voltage No-Go	In Flight Voltage No-Go
21	Xmsn Top	10 Kc	0.26	0.31
		5 Kc	0.37	0.46
22	Xmsn Base	10 Kc	0.24	0.30
		5-Kc	0.34	0.42
23	Aft Eng.	250 cps	0.065	0.088
24	Fwd Eng.	250 cps	0.041	0.061
25	Tail	250 cps	0.054	0.059
26	Lo Freq. Mast	20 cps	0.0033	0.012

Equipment used to determine the values referenced in Table 2 include the R-C oscillator, 20 cycles-500 kilocycles, Type NO1210-C, and the Unit Power Supply, Type 1203-B, both manufactured by General Radio Co.

Voltages were recorded from Ballantine Model 310 on 115 volts, 60 cycle supply.

NOTE

A 10-second (approximate) delay is in all vibration channels to prevent flickering of the caution lights when the input level varies intermittently at the triggering level.

ENGINE OIL FLOW - CHANNEL 29

TABLE 3. ENGINE OIL FLOW, CALIBRATION SETTINGS

Signal Input Voltage	Oil Flow Light On cps	Oil Flow Light Off cps
0.01	48	53
0.05	49.5	55
0.1	49.5	56
0.5	49.5	56

Oil Flow light illuminates as oil flow decreases since the flowmeter is on the scavenge side of the oil system. The values referenced in Table 3 were obtained by the same methods and procedures employed for the vibration channels (Table 2).

Calibration charts of flowmeter are shown in Figure 2 and Figure 3.

CALIBRATION NO: <u>1/2" L-1361</u> TYPE OF FLUID: <u>MIL-H-560A-UNIVIS- J43 &amp; #2 Fuel Oil</u> FLUID VISCOSITY: <u>5</u> Cnstks. @ <u>70° F.</u> TEST STAND: <u>L</u> DATE: <u>11-23-60</u> CALIBRATED BY: <u>Reiss</u> PRESSURE TEST: <u>Testing</u>										POTTER AERONAUTICAL CORP. U. S. Route 22, Union, N. J. <div style="border: 1px solid black; padding: 5px; text-align: center;"> <b>POTTERMETER</b>            MODEL NO: <u>1/2-1003A</u>            FLOW CALIBRATION         </div> ORDER NO: <u>Repair</u> THRUST (upstr): _____ STOPS (dnstr): _____ BOUNDARY COEFFICIENT: _____										SENSOR SERIAL NO: <u>ISNY-1/2-1</u> NUMBER OF PULSES/REV: <u>1</u> HOUSING MATERIAL: <u>Stainless - 303</u> GUIDE MATERIAL: <u>Silver Graphite</u> ROTOR MATERIAL: <u>Stainless - 20</u> ROTOR BLADE ANGLE: <u>20°</u> COIL NO: <u>PC2-5C</u> QUANT: _____									
REMARKS: <u>Mixed 5606A oil &amp; #2 fuel oil to get proper viscosity - 1 more calib. - 2 required. Voltage taken directly from coil.</u>																													
Pt. No.	Wt. lbs.	Vol. Gals. (sp. gr. = 1.0000)	Fluid Sp. Gr. (True)	Fl. temp. °F.	True Vol gals. (U.S.)	Time min.	Total cycles	Approx Freq. cps.	True Freq. cps.	Grav. Flow lbs./hr.	Vol. Flow gal./min.	Cycles per Gallon	Deviations value	%	Press Drop psi.	Back Press psi.	Emf mv. (rms)												
1	25.00					0.2713	2745	170*			13.480	750.57					390												
2		3.0018				0.2715	2744	170*			13.470	750.29																	
3			0.8208			0.2962	2747	150			12.347	751.11					360												
4				70°		0.3594	2754	125			10.176	753.02					295												
5					3.6572	0.4399	2751	100			8.314	752.21					270												
6						0.4414	2754	100			8.286	753.02																	
7						0.4953	2759	90			7.384	754.39					200												
8						0.5673	2761	80			6.447	754.94					175												
9						0.6544	2765	70			5.589	756.03					155												
10						0.7697	2769	60			4.752	757.12					130												
11						0.9064	2766	50			4.035	756.31					115												
12						0.9101	2770	50			4.018	757.40																	
13						1.1427	2774	40			3.200	758.49					95												
14						1.4365	2754	30			2.546	753.02					72												
15						1.7227	2740	25			2.123	749.20					60												
16						2.1423	2712	20			1.707	741.54					51												
17						2.5774	2670	15			1.419	730.06					40												
18						3.7593	2560	10			0.973	699.98					30												
19						3.7566	2564	10			0.974	701.07																	
20																													
Mean Total Cycles (per Weight used): _____ Sensing Element Constant (mean cycles/gal.): _____										Calibration Accepted: _____ Rejected: _____ By: _____ Date: _____																			

Form E-101 A

CP1355

FIGURE 2. FLOW CALIBRATION CHART

CALIBRATION NO: 1/2" L-1362

TYPE OF FLUID: MIL-H-5606A-UNIVIS-143

FLUID VISCOSITY: 20 Csnarks. @ 58°F.

TEST STAND: L

DATE: 11-26-60

CALIBRATED BY: Reiss

PRESSURE TEST: psig.

POTTER AERONAUTICAL CORP.  
U.S. ROUTE 22, UNION, N.J.

POTERMETER

MODEL NO: 1/2-1003A

FLOW CALIBRATION

ORDER NO: Repair

THRUST (upstr):

STOPS (dnstr):

BOUNDARY COEFFICIENT:

SENSOR SERIAL NO: BSNY-1/2-1

NUMBER OF PULSES/REV: 1

HOUSING MATERIAL: Stainless - 303

GUIDE MATERIAL: Silver Graphite

ROTOR MATERIAL: Stainless - 20

ROTOR BLADE ANGLE: 20°

COIL NO. PC2-5C

QUANT: 1

REMARKS: Final calib. - 2 required. (\*Limit of one test rig) Voltage taken directly from coil.

Pt. No.	Wt. lbs.	Vol. Gals. (sp. gr. = 1.0000)	Fluid Sp. Gr. (U.S.)	Fl. temp OF.	True Vol gals. (U.S.)	Time min.	Total cycles	Approx. Freq. cps.	True Freq. cps.	Grav. Flow lbs./hr.	Vol. Flow gal./min.	Cycles per Gallon	Deviations value %	Press Drop psi.	Back Press psi.	Emf mv. (rms)
1	2500					0.2786	2691	160*			12.879	761.80				480
2		3.0018				0.2789	2690	160*			13.024	761.51				
3			0.8498			0.3128	2695	150			11.293	762.93				360
4				58°		0.3597	2695	125			9.821	762.93				310
5					3.5324	0.4480	2689	100			7.885	761.23				260
6						0.4449	2691	100			7.939	761.80				
7						0.4930	2695	90			7.165	762.93				235
8						0.5560	2685	80			6.353	760.10				210
9						0.6251	2677	70			5.651	757.83				
10						0.7340	2658	60			4.813	752.45				165
11						0.8782	2628	50			4.022	743.96				
12						0.8769	2634	50			4.028	742.83				
13						1.0803	2590	40			3.269	733.20				105
14						1.3857	2573	30			2.549	728.39				135
15						1.6614	2543	25			2.126	719.90				69
16						2.0152	2535	20			1.753	717.63				57
17						2.4743	2506	15			1.428	709.42				45
18						3.6139	2444	10			0.977	691.88				
19						3.6191	2447	10			0.976	692.72				
20																

Mean Total Cycles (per weight used):

Sensing Element Constant (mean cycles/gal.):

For: E-101A

Calibration Accepted: \_\_\_\_\_

Rejected: \_\_\_\_\_

By: \_\_\_\_\_ Date: \_\_\_\_\_

FIGURE 3. FLOW CALIBRATION CHART

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## TEMPERATURE CALIBRATION SETTINGS

TABLE 4. TEMPERATURE CALIBRATION SETTINGS

Channel		Ambient Temperature = +20°C		Ambient Temperature = +40°C	
			Ohms		Ohms
31	Swashplate	45°C	456	55°C	468
32	Xmsn Input	80°C	500	90°C	512
33	Fwd. Shaft	100°C	525	110°C	538
34	Mid Shaft	100°C	525	110°C	538
35	Aft Shaft	100°C	525	110°C	538
36	42°G. B.	95°C	518	105°C	532
37	90°G. B.	65°C	482	75°C	494

Temperature settings as referenced in Table 4 were determined by substituting calibrated variable resistances in place of the thermal ribbons.

### NOTE

When reading thermal ribbon resistances, use extreme care to prevent introducing additional errors.

A 5-ohm error in reading the ambient temperature resistance can cause a 20°C error. Each ohm is equal to 4°C.

The sensor temperature resistance ratio is 0.8°C/ohm.

To read the thermal ribbon resistances directly, disconnect J1 and J5 from rear of "ALARM" control/display box. Measure ribbon resistance directly. (The resistance as read from the test panel is the circuit resistance, not the thermal ribbon alone.)

The conversion chart of circuit resistance vs sensor is shown in Figure 4. Thermal ribbon calibration resistance is shown in Figure 5.

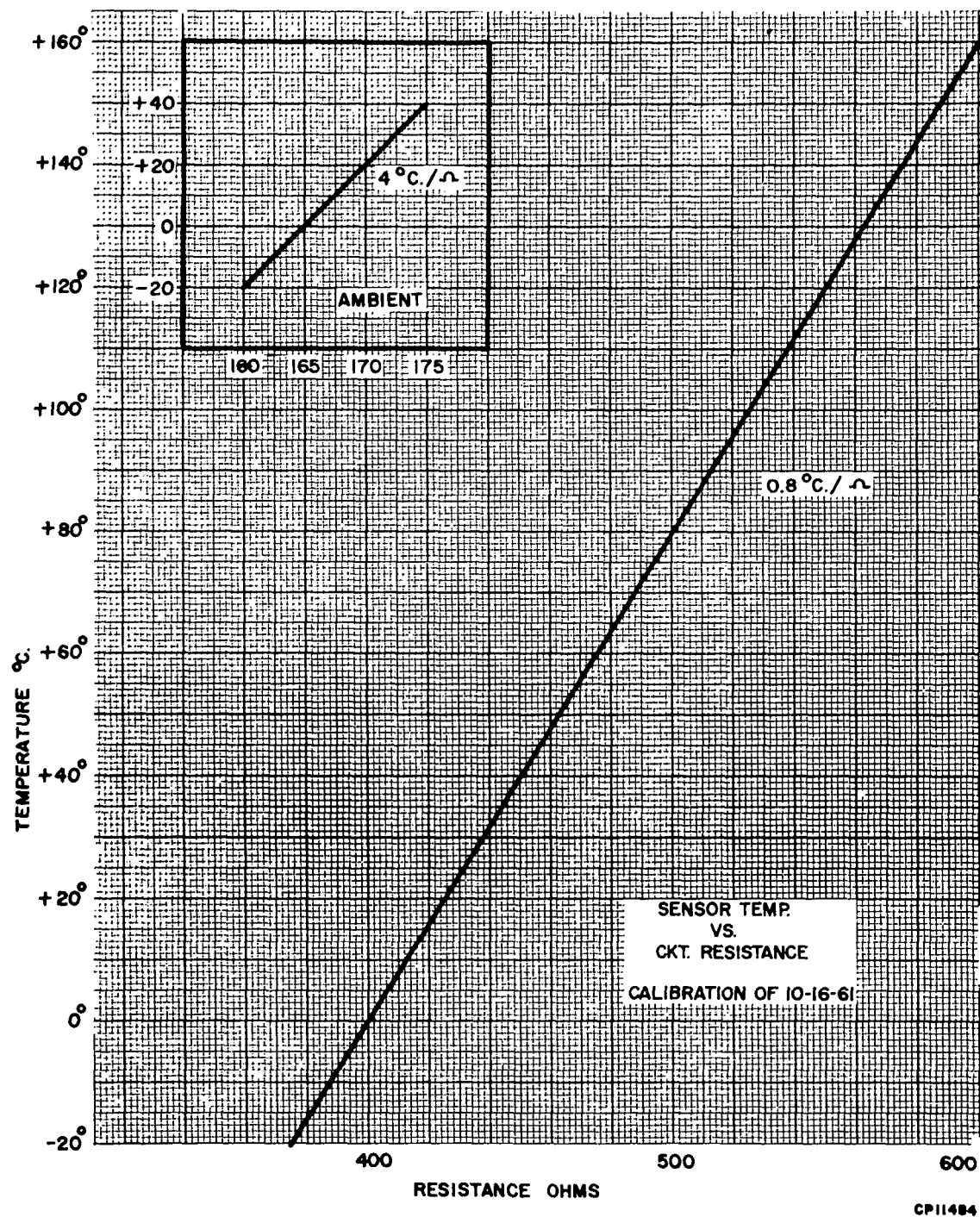


FIGURE 4. SENSOR TEMPERATURE VS CIRCUIT RESISTANCE

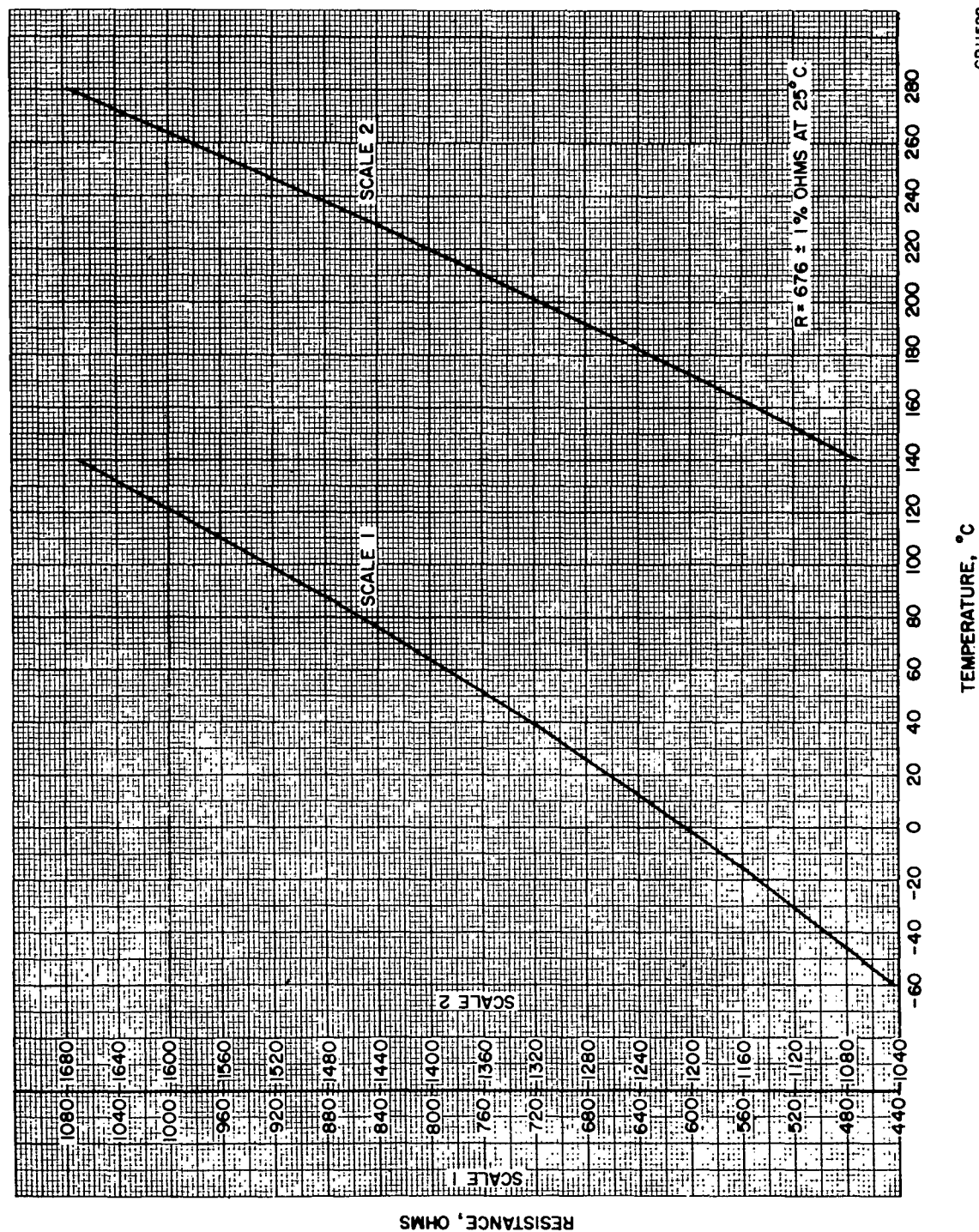


FIGURE 5. THERMAL RIBBON CALIBRATION CURVE

## ALARM SYSTEM POWER SUPPLY

### Current Load & Voltage 12.0 & 4.5V Supply

TABLE 5. POWER SUPPLY PARAMETERS

Mode	12.0V Supply		4.5V Supply	
	Amp	Volts	Amp	Volts
Self-Check Neutral	0.35	11.9	0.32	4.4
Self-Check Hi	0.1	11.9	0.5	4.2
Self-Check Lo	0.35	11.9	0.28	4.4
Static	0.32	11.95	0.30	4.4
Dynamic	0.32	11.97	0.31	4.5
In Flt	0.32	11.97	0.33	4.5

Voltages and current load readings referenced in Table 5 were taken while the aircraft power supply was deenergized. An ancillary D. C. power supply of 28.5 volts was used in place of the aircraft power supply.

### Plug-In Test Panel Arrangement

A plug-in test panel has been provided with the breadboard ALARM System as a convenient method to measure various sensor outputs. These output locations are identified in Figure 6.

### CAUTION

Turn ALARM System OFF before taking temperature resistance readings.

Use extreme care in reading thermal ribbon resistances to prevent introducing additional errors.

### FLIGHT/GROUND RUN TEST CHECK LIST

The following procedures were employed by personnel at the aircraft to obtain the test data referenced in this document.

XMSN TOP VIB.	●	●	AMBIENT TEMP.
XMSN BASE VIB.	●	●	SWASH PLATE TEMP.
AFT ENG VIB.	●	●	INPUT QUILL TEMP.
FWD ENG VIB.	●	●	FWD. SHAFT HGR. BRG. TEMP.
TAIL VIB.	●	●	MID SHAFT HGR. BRG. TEMP.
LO FREQ MAST VIB.	●	●	AFT SHAFT HGR. BRG. TEMP.
ENG SPEED	●	●	42° GB TEMP.
SPARE	●	●	90° GB TEMP.
GROUND	●	●	SPARE

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FIGURE 6. PLUG-IN TEST PANEL LAYOUT

<u>Step</u>	<u>Condition</u>
1	<u>Prior to Start</u> Record initial (cold) resistances of temperature channels. Battery Switch "ON", Spare Inverter "ON". Depress "BATT TEST" button. <ol style="list-style-type: none"> <li>1. Circuit breaker should trip.</li> <li>2. Reset circuit breaker.</li> </ol> ALARM selector switch in "SELF CHECK (HI & LO)" positions. ALARM selector switch in "STAT" position. ALARM selector switch in "OFF" position.
2	<u>Engine Start</u>
3	<u>As Soon As Power Is Available</u> ALARM selector switch to "DYN" position. Observe dynamic indications.
4	<u>Increase RPM to 6400, Hold Steady</u> Center "Cyclic" stick. Record any ALARM dynamic indications.
5	<u>Proceed with Take-Off or Hold For 6400 RPM Ground Run</u> Instruct aircraft operator on attitude desired. Record data as required.
6	<u>Prior to Shutdown</u> Test Battery Check <ol style="list-style-type: none"> <li>1. Depress "BATT TEST" button.</li> <li>2. If breaker does not trip, battery is sufficiently charged.</li> <li>3. If breaker trips, more than 5 amps are going into the battery and the A/C should not be shut down. The battery is not charged enough to insure that a start can be made.</li> </ol>

---

Step

Condition

6 (Cont'd)

CAUTION

Do not attempt to start the aircraft with the ALARM System unplugged. The ground for the battery switch is now through the ALARM System.

To start the aircraft with the ALARM System unplugged, the ground on the battery switch (located above the battery switch in the overhead console) must be replaced.

7

After Shutdown

Record temperature data.

Record running time.

OPERATOR'S CHECK LIST FOR THE ALARM SYSTEM

Step

Condition

1

Prior to Start

Battery Switch "ON", Spare Inverter "ON".

Depress "BATT TEST" button.

1. Circuit breaker should trip.

2. Reset circuit breaker.

ALARM selector switch in "SELF CHECK (HI & LO)" positions.

ALARM selector switch in "STAT" position.

ALARM selector switch in "OFF" position.

2

Engine Start

3

As Soon As Power Is Available

ALARM selector switch to "DYN" position.

Note dynamic indications.

4

Increase RPM to 6400, Hold Steady

Center "Cyclic" stick.

Note any ALARM dynamic indications.

<u>Step</u>	<u>Condition</u>
5	<u>Switch to "IN FLT" Mode</u> Proceed with take-off. Note any ALARM indications.
6	<u>Prior to Shutdown</u> Test Battery Check <ol style="list-style-type: none"> <li>1. Depress "BATT TEST" button.</li> <li>2. If breaker does not trip, battery is sufficiently charged.</li> <li>3. If breaker trips, more than 5 amps are going into the battery and the aircraft should not be shut down. The battery is not charged enough to insure that an engine start can be made.</li> </ol>

#### CAUTION

Do not attempt to start the aircraft with the ALARM System unplugged. The ground for the battery switch is now through the ALARM System.

To start the aircraft with the ALARM System unplugged, the ground on the battery switch (located above the battery switch in the overhead console) must be replaced.

7	<u>Shutdown Aircraft</u> Deenergize ALARM System.
---	--

## ALARM OPERATIONAL PROBLEMS

In addition to the problems discussed in the installation, operational and functional checks, various other problems were encountered. None were considered serious, although several were time-consuming in determination of the specific problem. The two most time-consuming problems concerned a wiring error in the control/display box, and undersize pins in the coaxial cable connectors.

The wiring error was determined as a result of a difficulty encountered in trying to set the vibration indicating level of the forward and aft engine channels. The problem became apparent when it was impossible to maintain a setting consistently after adjustment of either dynamic or in-flight modes. If the dynamic setting was correct, then the in-flight setting was not and vice versa. This inconsistency was traced to a wiring error at the mode switch. The terminations to the switch for the dynamic and in-flight modes were reversed. This caused the in-flight vibration level to be at a lower level than the dynamic level. This condition does not exist. The vibration indication would illuminate immediately if the in-flight condition was correct and the dynamic condition would be checked. If the dynamic condition would be adjusted correctly, then the in-flight condition could not be made to indicate. Changing the leads to the proper terminals at the mode switch eliminated this problem.

The undersize pins were found due to erratic test data from several of the vibration channels, indicating a discontinuity in the circuit. Complete checks of the circuits electrically failed to disclose a break. The erratic behavior made it difficult to diagnose. A trial and error method in determining the problem resulted in the determination that the pins in the coaxial connectors were undersized. Replacement of the connectors solved the problem.

Another problem of erratic test data led to the power supply. This was determined to be a cold solder joint in the power supply causing a voltage spike which was far greater than the system design allowance. A resolder of the joint eliminated the problem.

Early in the operational checkout of the ALARM System, the voltage level of the aircraft battery would drop below the 23.5 vdc level and the ALARM System would not operate. This operational failure was due to the protecting relay in the ALARM circuit. No problem was involved in starting the aircraft and the d-c voltmeter in the aircraft always read at least 28 vdc when the engine was operating. The voltage drop was not detected immediately due to these factors.

A discrepancy in test equipment identification was found early in the flight test portion of the reinstallation phase. The Ballantine Model 316 voltmeter had been specified as the piece of test equipment used during flight test. The test data derived utilizing the Model 316 voltmeter did not agree with previous test data. Investigation led to the discrepancy in that the Model 316 is designed for a 60-cycle power supply and the aircraft power supply is 400 cycles. Substitution of a Ballantine Model 310 rectified the error.

The transmission chip detector was giving a false indication on a hot day after a considerable ground run time. A check of the resistance of this circuit showed the resistance varied considerably according to the temperature. A check with the manufacturer determined that during the manufacturing process the resistance could not be held to a consistent figure. It was decided to increase the resistance in the circuit to eliminate this problem. This improved the performance but did not completely eliminate the problem. The engine and both gear box detectors did not present the same problem.

The battery test circuit did not appear to operate properly and a check of the circuit determined that the electrical wiring was incorrect. The wire that should have gone to the relay load was wired to the relay coil. Correct wiring eliminated this problem.

## ALARM SYSTEM DISCUSSION

The ALARM System reinstallation phase was not a test phase of the over-all program. This reinstallation phase was to insure that the system was functioning properly, and test data obtained at this time was merely to support this application. The test data does agree with the trends as indicated by the Phase II test program. (TRECOM Technical Report 63-10, Vol. I and Vol. II).

Conclusions are based upon the test data and operation of the ALARM System. The one factor most significant was the consistency of the ALARM indications as they occurred during the flight and ground-run operation of the aircraft during this phase.

The ALARM NO GO indications following the reinstallation, were for the most part valid; with the possible exception of the vibration area. The vibration area, as discussed in TRECOM Technical Report 63-10 Vol. I and Vol. II, is in the grey or "doubtful" area. Insufficient test data and history has not allowed determination of the operating limits for the vibration channels. The indication level is presently set at a level just above the normal operating level, as it was during the test phase. At this level, tests have shown some indications will be given when a malfunction is not present. The other aspect, however, is that the possibility exists that the vibration level indicated by the ALARM System is beyond the normal range, and extended operation at this level could be detrimental. Again, no limits have been set and cannot be determined until further study and tests have been completed.

The ALARM System, when used as ground check-out equipment and not as a flight safety instrument, shows a much better record for the indication of a malfunction condition. This is due, primarily, to noncontrolled factors during flight. The determination of known malfunctions during ground tests, as permitted without endangering the aircraft or personnel, has shown the ALARM System is capable of differentiation between a known good component and a known malfunctioning component. These malfunctions included main rotor out of track and unbalance, tail rotor unbalance, oil leak, engine overspeed, tail rotor drive shaft hanger bearing overheat, access door security and magnetic chip detection.

The main rotor out of track and unbalance, and tail rotor unbalance were detected by the vibration channels. These conditions were artificially created by the addition of weight to the rotor blade or by the pitch change linkage adjustment.

The engine overspeed condition was simulated by reducing the maximum rpm setting to 6700 rpm in the ALARM System. The indication of overspeed was consistently provided at 6700 rpm and remained illuminated until the reset button was depressed.

The oil leak tests were both deliberate and accidental. The deliberate leaks were induced by opening a drain valve. The accidental leak occurred during a flight from the Bendix York Plant to Olmstead Air Force Base for refueling. The ALARM System gave a flickering indication of an oil loss prior to take-off. In flight, the oil leak indication became constant. The channel was adjusted, but the light could not be extinguished. Upon landing, the aircraft mechanic discovered the oil leak. It was determined that approximately three quarts of oil had been lost in the 15-minute flight. The leak resulted from a loose connection in the oil return line. The

connection was tightened and the oil system refilled. No further indication by the ALARM System was given after the oil flow channel was adjusted.

The access door security indications were given accidentally during ground runs when test equipment leads were extended through the power supply compartment. The leads did not allow the access doors to be latched and the static mode check always indicated the left-rear interlocks in a no-go condition.

The tail rotor drive shaft hanger bearing indicator illuminated during an extended hover condition into the wind. The mid shaft bearing indicated the bearing was hot. The aircraft was set down and the temperature checked by TRECOM personnel with a pyrometer. The pyrometer indicated a 5<sup>0</sup>F difference between the fore and mid, and the 5<sup>0</sup>F difference between the aft and mid hanger bearings. The Bell Helicopter representative could hold his hand on both the fore and aft bearing but could not touch the mid bearing. The ALARM System resistance reading indicated the mid shaft bearing temperature was above the 90<sup>0</sup>C limit imposed upon it.

Magnetic chip detection indications occurred during operation on the 90<sup>0</sup> gear box and the transmission. Both indications were valid. Neither condition was considered as detrimental to aircraft operation, but the presence of ferrous particles in the system was verified. The ferrous particles were not introduced into the system artificially but were generated by the normal operation of the aircraft.

The valid indication given by the breadboard system therefore amplifies the possibilities of a system that would be designed into the aircraft and backed by history to determine operating limits.

The ALARM program was limited by monetary and time considerations to the extent that it was not possible to cover the aircraft adequately to perform the requirements of the present aircraft maintenance inspections. The feasibility of the monitor points have been shown with the vibration points being questionable since no limits are known.

The time-saving factor has been placed in the background to a great degree since the monitor points are very difficult to compare with the inspection requirements on a time basis. During the Acceptance Test, a time comparison was made by TRECOM personnel, and the ALARM System was timed as taking approximately 5 minutes more than the present daily inspection. The ALARM System does, as emphasized, give a better indication of aircraft condition through the checks that are beyond the requirements of the present inspection procedures. The time comparison is perhaps questionable, since the ALARM System requires a dynamic condition of the aircraft, while the present inspection procedure does not. The aircraft may not be capable of becoming airborne, however, even though it has passed a daily inspection. The ability of an aircraft to become airborne is not known until the engine is started and checked out, even though this is not classed as an inspection. The excess time of 5 minutes is the time required to start and run-up the aircraft engine; not additional time required to complete inspection.

The ALARM System, to be effective, must be considered as a tool of inspection, and the aircraft inspection procedure must be based upon the ALARM capabilities and not on the basis of the present inspection procedures.

### RECOMMENDED ADDITIONAL ALARM CHANNELS

The monitoring channels for the present ALARM System were selected 3 months after inception of the program. (Reference: TREC Report 60-49.) The study and research during this period was therefore limited. Since the inception of this program, experience with the aircraft and discussions with pilots and maintenance personnel has led to the conclusion that additional channels can be implemented into the test bed aircraft with very little modification.

The placement of additional temperature sensors at the engine and transmission could enable trouble shooting to become more definitive. At the present time, the temperature sensors have been located at points which were chosen as the most obvious for temperature changes. The test phase (TRECOM Report 63-10 Vol. I and Vol. II), resulted in at least one change in the location of a temperature sensor.

The addition of pressure sensors in both the fuel and oil system could further isolate malfunctions. The present indicators are located adjacent to the pump making the readings a good indicator of the pump condition but not necessarily an indicator of the system condition. An additional flowmeter, to be used in conjunction with the present installation, could be an improvement to indicate a smaller leak rate. The present leak rate of one pint per minute can feasibly be reduced by 50%.

The addition of a hydraulic oil level indicator would eliminate the requirement for checking of this level visually.

The implementation of a strain gage and/or load cell for evaluation of this type sensor for inspection feasibility would also be desirable. At the present time, no sensors of this type are used.

The addition of special sensors to the engine and engine compartment would provide the aircraft operator with more information on the engine condition. A "hot-start" indicator with a lock-in circuit as used in engine overspeed would be valuable to indicate when the engine requires a hot-start inspection. Under the present inspection system, a hot start can occur; but if it does not appear to be serious, it is up to the aircraft operator's discretion as to whether the incident should be reported. The automatic equipment would relieve the operator of this responsibility.

An indicator for an overtorque condition would be in basically the same category and the benefits would be of the same magnitude as the hot start.

Turbine engine flame-out has been a problem in detection. The reaction time of most detectors is too slow to be effective. The reaction time has been estimated as slow as 5 seconds. The possibility of using an optic flame detector with the ability to detect the presence or absence of flame has been developed. The reported reaction time is in microseconds. With this reaction time, it would be possible to automatically detect flame-out and initiate corrective action before the aircraft operation is aware the condition has occurred. This would not be a portion of the inspection requirement but a flight safety item.

The electrical power supply system for the aircraft can be implemented to a greater degree with the addition of electrical sensors to measure voltage, current, and resistance. The addition of the sensors will provide information on the condition of the generator, inverter, transformers, essential and nonessential buss. Individual circuits, such as ignition system and fuel boost pump, may be monitored to indicate the condition of the electrical components. Practically all of these recommended additional points were considered during the research and study phase of this project. The conclusions and decisions of this research and study phase are covered by TREC Report 60-49. The basis for the elimination of many of the points was the undetermined value of the implementation versus the cost allotted to the test program. Duplicate monitors, such as a liquid level indicator on the hydraulic system, could have been added, but the program was to include a feasibility program as well, and the redundancy of the detector was not considered worth the expenditure for installation.

This initial phase of the ALARM development was limited by monetary, feasibility, and time considerations. Many points which were not monitored may be considered mandatory in the future.

### TEST DATA

All raw test data for the vibration channels is in RMS volts unless specified otherwise. The temperature channel data is in ohms.

The Converted Data Summary is the significant data reduced to the equivalent terms as used and discussed in TRECOM Technical Report 63-10, Vol. I.

Mast bearing temperatures recorded on the Data Sheets are transmission input quill temperatures.

### TEST DATA CONVERSION FACTORS

The conversion factors used in converting the raw data from RMS voltage to peak "G" or velocity vector were derived from the calibration data of the vibration sensors.

These factors as applied to each vibration channel are listed in Table 6.

TABLE 6

TEST DATA CONVERSION FACTORS, VIBRATION CHANNELS

<u>Channel No.</u>	<u>Nomenclature</u>		
21	XMSN Top	RMS Voltage x 31.4 =	g peak
22	XMSN Base	RMS Voltage x 35.4 =	g peak
23	Aft Eng	RMS Voltage x 14.72 =	in/sec peak
24	Fwd Eng	RMS Voltage x 14.15 =	in/sec peak
25	Tail	RMS Voltage x 14.15 =	in/sec peak
26	Lo Freq		
	3-24 cps	RMS Voltage x 25.47 =	in/sec peak
	24-50 cps	RMS Voltage x 39.62 =	in/sec peak
	50-100 cps	RMS Voltage x 77.54 =	in/sec peak
	All	RMS Voltage x 25.47 =	in/sec peak

CONVERTED DATA SUMMARY

The following tables list significant converted test results.

DATE	AIRCRAFT ATTITUDE	FREQUENCY (KCPS) BAND							
		.5-1	1-2	2-4	4-8	8-12	12-16	16-20	.5-20
6-28-62	Straight and level flight 70 knots.	7.434	4.956	9.204	8.142	6.372	4.956	3.363	12.740
6-28-62	Straight and level flight 70 knots.	0.708	4.602	8.142	8.496	5.310	4.956	1.770	12.390
7-11-62	Straight and level flight 70 knots.	0.814	4.248	8.142	8.142	4.956	3.894	2.761	11.680
7-11-62	Straight and level flight 70 knots.	0.672	4.248	7.080	8.142	5.310	4.956	3.327	12.030
7-20-62	Straight and level flight 70 knots.	0.743	4.602	8.496	9.204	4.956	3.540	2.336	12.390
6-29-62	Ground Run 6400 RPM	0.708	3.894	8.850	8.142	4.956	3.540	2.124	11.680
6-29-62	Ground Run 6400 RPM	0.814	3.540	8.142	7.434	4.248	2.655	1.770	10.620
7-10-62	Ground Run 6400 RPM	0.672	3.540	8.142	8.142	4.602	3.186	2.230	11.680
7-11-62	Ground Run 6400 RPM	0.672	3.363	7.434	7.434	3.894	3.009	1.947	10.260
7-11-62	Ground Run 6400 RPM	0.637	3.540	7.788	7.434	4.602	4.602	2.938	10.970
7-23-62	Ground Run 6400 RPM	0.637	3.540	6.372	6.018	6.372	3.894	2.478	95.580
6-28-62	Hover Out-of-Ground Ef- fect	0.814	2.832	7.080	7.788	5.664	6.018	3.186	13.450
7-11-62	Hover Out-of-Ground Ef- fect	1.026	4.602	6.726	9.204	5.310	4.602	2.761	11.680
7-11-62	Hover - 15 Feet	0.708	3.894	6.726	7.788	5.310	5.310	2.902	10.620
6-28-62	Autorotate								10.620
6-28-62	Autorotate								12.740

TABLE 7. XMSN BASE VIBRATION G'S PEAK

(CONTINUED)

DATE	AIRCRAFT ATTITUDE	FREQUENCY (KCPS) BAND							
		.5-1	1-2	2-4	4-8	8-12	12-16	16-20	.5-20
7-11-62	Autorotate								12.390
6-28-62	Climb - 500 ft./min.								12.390
6-28-62	Climb - 500 ft./min.								12.740
7-11-62	Climb - 500 ft./min.								11.680

TABLE 7. XMSN BASE VIBRATION G'S PEAK

DATE	AIRCRAFT ATTITUDE	FREQUENCY (KCPS) BAND									
		.5-1	1-2	2-4	4-8	8-12	12-16	16-20	.5-20		
6-28-62	Straight and level flight 70 knots.	0.879	2.512	8.790	13.500	9.420	3.140	1.476	14.440		
6-28-62	Straight and level flight 70 knots.	0.942	2.512	8.792	14.130	7.222	2.826	1.413	14.440		
7-11-62	Straight and level flight 70 knots.	0.879	2.606	7.850	11.930	7.850	2.888	1.413	13.810		
7-11-62	Straight and level flight 70 knots.	0.816	2.637	8.164	13.180	6.908	2.826	1.381	14.130		
7-20-62	Straight and level flight 70 knots.	0.753	2.763	8.478	12.870	7.222	2.637	1.350	14.750		
6-29-62	Ground Run 6400 RPM	1.193	2.198	9.420	14.130	10.040	4.082	1.570	16.640		
6-29-62	Ground Run 6400 RPM	1.161	2.826	10.360	13.810	9.734	3.140	1.350	16.320		
7-10-62	Ground Run 6400 RPM	1.036	2.323	8.478	12.560	10.360	3.925	1.570	16.320		
7-11-62	Ground Run 6400 RPM	1.099	2.198	9.106	13.180	9.734	3.768	1.682	15.700		
7-11-62	Ground Run 6400 RPM	1.036	2.355	8.792	13.180	8.792	3.454	1.507	15.380		
7-23-62	Ground Run 6400 RPM	0.910	2.417	9.420	12.240	8.478	3.140	1.413	16.010		
6-28-62	Hover Out-of-Ground Ef- fect	1.099	2.512	7.850	13.500	7.850	2.198	1.727	14.130		
7-11-62	Hover Out-of-Ground Ef- fect	0.847	3.454	7.220	14.750	8.478	3.454	1.350	14.130		
7-11-62	Hover - 15 feet	0.942	3.140	7.850	13.500	8.164	3.140	1.570	15.380		
6-28-62	Autorotate								10.990		
6-28-62	Autorotate								15.700		

TABLE 8. XMSN TOP VIBRATION G'S PEAK

(CONTINUED)

DATE	AIRCRAFT ATTITUDE	FREQUENCY (KCPS) BAND							
		.5-1	1-2	2-4	4-8	8-12	12-16	16-20	.5-20
7-11-62	Autorotate								13.500
6-28-62	Climb - 500 ft./min.								16.320
6-28-62	Climb - 500 ft./min.								14.750
7-11-62	Climb - 500 ft./min.								14.130

TABLE 8. XMSN TOP VIBRATION G'S PEAK

DATE	AIRCRAFT ATTITUDE	FREQUENCY (CPS) BAND							
		20-40	40-80	80-160	160-320	320-500	500-1kc	1-2kc	20-2000
6-28-62	Straight and level flight 70 knots	0.294	0.147	0.117	0.588	0.956	0.309	0.088	1.177
6-28-62	Straight and level flight 70 knots.	0.294	0.147	0.103	0.624	1.030	0.338	0.103	2.502
7-11-62	Straight and level flight 70 knots.	0.235	0.110	0.125	0.559	0.853	0.264	0.085	1.089
7-11-62	Straight and level flight 70 knots.	0.338	0.110	0.095	0.632	0.942	0.338	0.095	0.588
7-20-62	Straight and level flight 70 knots.	0.338	0.132	0.113	0.618	0.942	0.309	0.094	1.000
6-29-62	Ground Run 6400 RPM	0.206	0.073	0.147	0.368	0.397	0.117	0.073	0.515
6-29-62	Ground Run 6400 RPM	0.220	0.073	0.117	0.441	0.485	0.147	0.088	0.647
7-11-62	Ground Run 6400 RPM	0.191	0.073	0.117	0.412	0.426	0.125	0.073	0.544
7-23-62	Ground Run 6400 RPM	0.147	0.095	0.103	0.544	0.618	0.161	0.073	0.721
6-28-62	Hover Out-of-Ground Ef- fect	0.441	0.147	0.103	0.471	0.883	0.353	0.117	0.103
7-11-62	Hover Out-of-Ground Ef- fect	0.382	0.191	0.117	0.559	0.956	0.338	0.098	0.103
7-11-62	Hover - 15 feet	0.294	0.117	0.883	0.662	0.736	0.323	0.103	0.956
6-28-62	Autorotate								0.323
6-28-62	Autorotate								0.001
7-11-62	Autorotate								0.456
6-28-62	Climb - 500 ft./min.								1.104
7-11-62	Climb - 500 ft./min.								1.104

TABLE 9. AFT ENGINE VIBRATION VECTOR VELOCITY  
INCH/SECOND

DATE	AIRCRAFT ATTITUDE	FREQUENCY (CPS) BAND									
		20-40	40-80	80-160	160-320	320-500	500-1kc	1kc-2kc	20-2kc		
6-28-62	Straight and level Flt. 70 knots.	0.254	0.127	0.070	0.396	0.707	0.198	0.141	0.778		
6-28-62	Straight and level Flt. 70 knots.	0.212	0.113	0.070	0.094	0.636	0.226	0.141	0.707		
7-11-62	Straight and level Flt. 70 knots.	0.254	0.113	0.066	0.382	0.523	0.183	0.134	0.679		
7-11-62	Straight and level Flt. 70 knots.	0.311	0.113	0.066	0.452	0.665	0.240	0.134	0.396		
6-29-62	Ground Run 6400 RPM	0.070	0.042	0.070	0.183	0.212	0.099	0.141	0.311		
6-29-62	Ground Run 6400 RPM	0.070	0.049	0.056	0.141	0.183	0.169	0.183	0.339		
7-11-62	Ground Run 6400 RPM	0.042	0.049	0.067	0.176	0.212	0.099	0.127	0.297		
7-23-62	Ground Run 6400 RPM	0.084	0.066	0.070	0.240	0.268	0.099	0.127	0.339		
6-28-62	Hover Out-of-Ground Ef- fect	0.353	0.084	0.070	0.311	0.608	0.226	0.141	0.849		
7-11-62	Hover Out-of-Ground Ef- fect	0.325	0.106	0.063	0.410	0.665	0.155	0.134	0.735		
7-11-62	Hover - 15 Feet	0.212	0.056	0.070	0.382	0.452	0.212	0.141	0.594		
6-28-62	Autorotate								0.183		
6-28-62	Autorotate								0.141		
7-11-62	Autorotate								0.212		
6-28-62	Climb - 500 ft./min.								0.849		
6-28-62	Climb - 500 ft. / min.								0.707		
7-11-62	Climb - 500 ft./min.								0.792		

TABLE 10. FORWARD ENGINE VIBRATION VECTOR VELOCITY  
INCH/SECOND

DATE	AIRCRAFT ATTITUDE	FREQUENCY (CPS) BAND							
		20-40	40-80	80-160	160-320	320-500	500-1kc	1-2kc	20-2kc
6-28-62	Straight and level flight 70 knots.	0.141	0.240	0.325	0.183	0.141	0.141	0.424	0.665
6-28-62	Straight and level flight 70 knots.	0.141	0.212	0.283	0.183	0.141	0.325	0.396	0.636
7-11-62	Straight and level flight 70 knots.	0.183	0.367	0.367	0.183	0.106	0.254	0.339	0.636
7-11-62	Straight and level flight 70 knots.	0.240	0.424	0.382	0.169	0.120	0.226	0.311	0.679
7-20-62	Straight and level flight 70 knots.	0.155	0.325	0.353	0.169	0.127	0.254	0.339	0.665
6-29-62	Ground Run 6400 RPM	0.141	0.283	0.325	0.155	0.113	0.424	0.523	0.764
6-29-62	Ground Run 6400 RPM	0.141	0.283	0.283	0.169	0.141	0.495	0.636	0.905
7-10-62	Ground Run 6400 RPM	0.141	0.283	0.283	0.183	0.424	0.707	0.919	0.127
7-11-62	Ground Run 6400 RPM	0.106	0.325	0.283	0.155	0.091	0.283	0.396	0.679
7-11-62	Ground Run 6400 RPM	0.113	0.325	0.297	0.141	0.084	0.311	0.396	0.679
7-23-62	Ground Run 6400 RPM	0.127	0.382	0.396	0.169	0.084	0.141	0.240	0.566
6-28-62	Hover Out-of-Ground Ef- fect	0.169	0.283	0.410	0.240	0.141	0.325	0.396	0.636
7-11-62	Hover Out-of-Ground Ef- fect	0.212	0.325	0.325	0.155	0.094	0.169	0.240	0.608
7-11-62	Hover Out-of-Ground Ef- fect	0.198	0.382	0.339	0.254	0.084	0.120	0.240	0.650
6-28-62	Autorotate								0.849
6-28-62	Autorotate								0.990

TABLE 11. TAIL VIBRATION VECTOR VELOCITY  
INCH/SECOND

(CONTINUED)

DATE	AIRCRAFT ATTITUDE	FREQUENCY (CPS) BAND							
		20-40	40-80	80-160	160-320	320-500	500-1kc	1-2kc	20-2kc
7-11-62	Autorotate								0.537
6-28-62	Climb - 500 ft./min.								0.608
6-28-62	Climb - 500 ft./min.								0.636
7-11-62	Climb - 500 ft./min.								0.537

TABLE 11. TAIL VIBRATION VECTOR VELOCITY  
INCH/SECOND

DATE	AIRCRAFT ATTITUDE	FREQUENCY (CPS) BAND							
		3-6	6-12	12-24	24-50	50-100	3-100		
6-28-62	Straight and level flight 70 knots.	0.022	0.636	0.331	0.198	0.046	0.662		
6-28-62	Straight and level flight 70 knots.	0.022	0.432	0.280	0.158	0.046	0.432		
7-11-62	Straight and level flight 70 knots.	0.127	0.305	0.254	0.150	0.031	0.427		
7-11-62	Straight and level flight 70 knots.	0.114	0.483	0.305	0.170	0.031	0.432		
7-20-62	Straight and level flight 70 knots.	0.203	0.356	0.254	0.118		0.509		
6-29-62	Ground Run 6400 RPM	0.063	0.140	0.101	0.059	0.023	0.254		
6-29-62	Ground Run 6400 RPM	0.076	0.452	0.076	0.037	0.023	0.178		
7-10-62	Ground Run 6400 RPM	0.101	0.152	0.076	0.051	0.155	0.165		
7-11-62	Ground Run 6400 RPM	0.152	0.127	0.076	0.043	0.055	0.203		
7-11-62	Ground Run 6400 RPM	0.152	0.101	0.068	0.039	0.017	0.178		
7-23-62	Ground Run 6400 RPM	0.089	0.063	0.050	0.039	0.011	0.127		
6-28-62	Hover Out-of-Ground Ef- fect	0.050	0.101	0.178	0.011	0.046	0.229		
7-11-62	Hover Out-of-Ground Ef- fect	0.101	0.203	0.127	0.059	0.019	0.254		
6-28-62	Autorotate						0.152		
6-28-62	Autorotate						0.254		
7-11-62	Autorotate						0.127		

TABLE 12. LOW FREQUENCY MAST VIBRATION VECTOR  
VELOCITY INCH/SECOND

DATE	AIRCRAFT ATTITUDE	FREQUENCY (CPS) BAND				
		3-6	6-12	12-24	24-50	50-100 3-100
6-28-62	Climb - 500 ft./min.					0.509
6-28-62	Climb - 500 ft./min.					0.636
7-11-62	Climb - 500 ft./min.					0.382

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DATE	AIRCRAFT ATTITUDE	SWASH- PLATE	XMSN INPUT QUILL	FWD SHAFT	MID SHAFT	AFT SHAFT	42° GB	90° GB	AMB. TEMP.
6-28-62	After 1-1/4 Hr. Flt.	32	64	48	48	56	72	40	40
6-28-62	15 Min. Flt. after Refuel	40	80	64	72	72	88	40	40
6-29-62	20 Min. Grd. Run	40	88	64	80	88	88	48	40
6-29-62	12 Min. Grd. Run	48	88	64	80	88	88	48	40
7-10-62	After 15 Min. Flt.	16	60	40	40	60	48	32	20
7-11-62	After 20 Min. Grd. Run	32	80	48	80	88	88	64	20
7-11-62	After 20 Min. Grd. Run 90° GB. Indication	32	88	72	88	88	88	72	40
7-11-62	After 20 Min. Flt.	32	72	40	48	64	80	40	20
7-11-62	After 25 Min. Hover	32	88	56	72	80	88	48	40
7-11-62	After shutdown. After 20 Min. Hover	17	72	60	80	80	72	40	20
7-11-62	After 20 Min. Flt.	24	90	56	64	72	88	56	40
7-20-62	After 45 Min. Flt.	24	72	48	48	48	80	40	40
7-23-62	After 42 Min. Grd. Run XMSN Input Quill Indication	24	88	72	88	96	88	48	40

TABLE 13. TEMPERATURES DEGREES CENTIGRADE

#### RAW TEST DATA

The following raw test data sheets represent actual test data compiled during the reinstallation phase.

# DATA RECORD

Date 6-28-62

Test Condition Initial Flt.

Time 2:20 P. M.

Checkout 2000 Ft. 70 Knots

Engine oil flow indicated at 3100

O.A.T. 30°C

RPM on descent. Amb. Temp.

Wind 0 - 5

recorded 20 minutes after shutdown

Weather Clear

Recorded By T. Corbet

Time of Run 20 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top	0.006	0.075	0.32	0.45	0.30	0.11	0.047	0.50
XMSN Base	0.02	0.13	0.25	0.26	0.14	0.11	0.06	0.37
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.								0.06
FWD Eng.								0.038
Tail								0.049
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.						0.015		
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)	420	450	420	460	450	450	450	175
Temps. (After)	420	460	450	450	450	460	440	170

CPI1808

# DATA RECORD

Date	<u>6-28-62</u>	Test Condition	<u>70 knots straight</u>
Time	<u>3:50 P. M.</u>		<u>and level at 2000 feet. Transmis-</u>
			<u>sion and 90° Gear Box Chip Detect-</u>
O.A.T.	<u>24° C</u>		<u>ors indicating. Improper detector</u>
Wind	<u>0-5</u>		<u>installation.</u>
Weather	<u>Clear</u>	Recorded By	<u>T. Corbet</u>
		Time of Run	<u>20 minutes</u>

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top	0.028	0.08	0.28	0.43	0.30	0.10	0.047	0.46
XMSN Base	0.021	0.14	0.26	0.23	0.18	0.14	0.095	0.36
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.	0.02	0.01	0.008	0.04	0.065	0.021	0.006	0.08
FWD Eng.	0.018	0.009	0.005	0.028	0.05	0.014	0.01	0.055
Tail	0.01	0.017	0.023	0.013	0.01	0.001	0.03	0.047
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.	0.0009	0.025	0.013	0.005	0.0006	0.026		
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)								
Temps. (After)								

CP11905

# DATA RECORD

Date 6-28-62

Test Condition Hover Out-of-

Time 4:05 P. M.

Ground Effect

O.A.T. 24°C

Wind 0-5

Weather Clear

Recorded By T. Corbet

Time of Run 10 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top	0.035	0.08	0.25	0.43	0.25	0.07	0.055	0.45
XMSN Base	0.023	0.08	0.20	0.22	0.16	0.17	0.09	0.38
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.	0.03	0.01	0.007	0.032	0.06	0.024	0.008	0.07
FWD Eng.	0.025	0.006	0.005	0.022	0.043	0.016	0.01	0.06
Tail	0.012	0.02	0.029	0.017	0.01	0.023	0.028	0.045
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.	0.002	0.004	0.007	0.003	0.0006	0.009		0.02
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)								
Temps. (After)								

CP11505

# DATA RECORD

Date 6-28-62 Test Condition 500 feet per  
Time 4:10 P. M. minute climb  
O.A.T 26°C  
Wind 0-5  
Weather Clear Recorded By T. Corbet  
Time of Run 5 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top								0.52
XMSN Base								0.35
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.								0.075
FWD Eng.								0.06
Tail								0.043
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.								0.02
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)								
Temps. (After)								

CP11505

# DATA RECORD

Date 6-28-62

Test Condition Autorotation

Time 4:15 P. M.

O.A.T. 26°C

Wind 0-5

Weather Clear

Recorded By T. Corbet

Time of Run 5 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top								0.35
XMSN Base								0.3
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.								0.022
FWD Eng.								0.013
Tail								0.06
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.								0.006
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)								
Temps. (After)								

CP11805

# DATA RECORD

Date 6-28-62 Test Condition Straight and level  
Time 4:25 P. M. at 2000 feet altitude.  
O.A.T. 22°  
Wind 0-5  
Weather Clear Recorded By T. Corbet  
Time of Run 15 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top	0.03	0.08	0.28	0.45	0.23	0.09	0.045	0.46
XMSN Base	0.02	0.13	0.23	0.24	0.15	0.14	0.05	0.35
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.	0.02	0.01	0.007	0.045	0.07	0.023	0.007	0.17
FWD Eng.	0.015	0.008	0.005	0.036	0.045	0.016	0.01	0.05
Tail	0.01	0.015	0.02	0.013	0.01	0.023	0.028	0.045
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.	0.0009	0.017	0.011	0.004	0.0006	0.017		
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)								
Temps. (After)								

CP11505

# DATA RECORD

**Date** 6-28-62 **Test Condition** 500 feet per  
**Time** 4:40 P. M. **minute climb**  
**O.A.T** 24°C  
**Wind** 0-5  
**Weather** Clear **Recorded By** T. Corbet  
**Time of Run** 5 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top								0.47
XMSN Base								0.36
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.								0.0001
FWD Eng.								0.05
Tail								0.045
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.								0.025
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)								
Temps. (After)								

# DATA RECORD

**Date** 6-28-62 **Test Condition** Autorotation  
**Time** 4:45 P. M.  
**O.A.T.** 24°C  
**Wind** 0-5  
**Weather** Clear **Recorded By** T. Corbet  
**Time of Run** 5 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top								0.5
XMSN Base								0.36
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.								0.0001
FWD Eng.								0.001
Tail								0.07
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.								0.01
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)								
Temps. (After)								

CP11805

# DATA RECORD

Date	<u>6-28-62</u>	Test Condition	<u>Temps. (Before)</u>
Time	<u>4:50 P. M.</u>		<u>recorded after 75 minute flight.</u>
			<u>Temps. (After) recorded after 15</u>
			<u>minute flight following above flight.</u>
O.A.T.	<u>26°C</u>		<u>90° Gear Box and Transmission</u>
Wind	<u>0-5</u>		<u>Chip Detector indication.</u>
Weather	<u>Clear</u>	Recorded By	<u>T. Corbet</u>
		Time of Run	<u></u>

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top								
XMSN Base								
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.								
FWD Eng.								
Tail								
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.								
	Swash Brg.	Master Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)	440	480	460	460	470	490	450	175
Temps. (After)	450	500	480	490	490	510	450	175

CP11805

# DATA RECORD

Date 6-29-62 Test Condition Ground Run at  
Time 2:20 P. M. 6400 RPM - Modification to engine  
transmission and tail vibration  
O.A.T. 30°C were made. ( Modifications were  
Wind 2 Knots changes in resistors in the modules.  
Weather Hazy Recorded By T. Corbet  
Time of Run 20 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top	0.038	0.07	0.30	0.45	0.32	0.13	0.05	0.53
XMSN Base	0.02	0.11	0.25	0.23	0.14	0.10	0.06	0.33
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.	0.014	0.005	0.01	0.025	0.027	0.008	0.005	0.035
FWD Eng.	0.005	0.003	0.005	0.013	0.015	0.007	0.01	0.022
Tail	0.01	0.02	0.023	0.011	0.008	0.03	0.037	0.054
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.	0.0025	0.0055	0.004	0.0015	0.0003	0.01		
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)	440	490	440	470	470	460	450	175
Temps. (After)	450	510	480	500	510	510	460	175

CP11803

# DATA RECORD

Date 6-29-62  
Time 3:50 P. M.  
O.A.T 28°C  
Wind 3 Knots  
Weather Hazy

Test Condition Ground Run 6400  
RPM - After oil flow and engine  
speed calibration check. Input quill  
temperature indication before this  
data was recorded- Total run time  
45 minutes.  
Recorded By T. Corbet  
Time of Run 12 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top	0.037	0.09	0.33	0.44	0.31	0.10	0.043	0.52
XMSN Base	0.023	0.10	0.23	0.21	0.12	0.075	0.05	0.30
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.	0.015	0.005	0.008	0.03	0.033	0.01	0.006	0.044
FWD Eng.	0.005	0.0035	0.004	0.01	0.013	0.012	0.013	0.024
Tail	0.01	0.02	0.02	0.012	0.01	0.035	0.045	0.064
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.	0.003	0.006	0.003	0.001	0.0003	0.007		
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)								
Temps. (After)	460	510	480	500	510	510	460	175

CP11806

# DATA RECORD

Date 7-10-62

Time 12:40 P. M.

O.A.T. 28°C

Wind 10 Knot N.W.

Weather Clear

Test Condition Check Flight

Transmission base and low frequency vibration indications.

Transmission oil pressure 62 PSI at 85 knots - Could not extinguish oil flow indication - On landing at Olmstead, oil leak in line at oil reservoir return line.

Recorded By T. Corbet

Time of Run 15 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top								
XMSN Base								
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.								
FWD Eng.								
Tail								
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.								
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)	410	425	420	440	440	425	425	170
Temps. (After)								

CP11805

# DATA RECORD

Date 7-10-62  
Time 2:00 P. M.  
O.A.T. 22<sup>0</sup>C  
Wind 10 Knots  
Weather Clear

Test Condition 70 knots straight  
and level at 2500 feet altitude.  
Transmission and low Frequency  
light could not be extinguished.  
Recorded By T. Corbet  
Time of Run 15 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top	1.0	0.90	0.46	0.28	0.13	0.10	0.10	1.4
XMSN Base	1.0	0.90	0.40	0.21	0.10	0.10	0.04	1.2
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.	0.25	0.16	0.12	0.38	1.3	1.0	0.80	1.7
FWD Eng.	0.30	0.17	0.11	0.42	1.1	0.90	0.35	0.04
Tail	0.30	0.20	0.11	0.4	1.2	0.70	0.5	0.08
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.	0.10	0.15	0.15	0.23	0.13	0.5		
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)								
Temps. (After)	420	475	450	450	475	460	440	170

CP11808

# DATA RECORD

Date	<u>7-10-62</u>	Test Condition	<u>Ground Run</u>
Time	<u>3:50 P. M.</u>		<u>6400 RPM - suspect faulty test</u>
			<u>equipment - replaced bandpass</u>
O.A.T.	<u>30°C</u>		<u>filter. XMSN oil press. w/mod.</u>
Wind	<u>5 K</u>		<u>valve at 6200 RPM - 42 PSI.</u>
Weather	<u>Clear</u>	Recorded By	<u>T. Corbet</u>
		Time of Run	<u>10 minutes</u>

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top	1.35	0.83	0.46	0.28	0.125	0.067	0.006	1.45
XMSN Base	1.35	0.85	0.46	0.28	0.125	0.067	0.0037	1.45
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.								
FWD Eng.								
Tail								
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.								
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)								
Temps. (After)								

CP11805

# DATA RECORD

Date 7-10-62

Test Condition Ground Run

Time 4:10 P. M.

6400 RPM

O.A.T. 30°C

Data not in line, changing leads

on input.

Wind 5 K

Weather Clear

Recorded By T. Corbet

Time of Run 15 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top	0.028	0.068	0.26	0.34	0.21	0.07	0.034	0.56
XMSN Base	0.015	0.09	0.20	0.19	0.09	0.062	0.038	0.33
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.	0.0047	0.0025	0.0012	0.0064	0.0025	0.001	0.0068	0.00025
FWD Eng.	0.0045	0.0022	0.0011	0.0068	0.0023	0.001	0.0064	0.00027
Tail	0.008	0.017	0.015	0.0085	0.007	0.048	0.029	0.095
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.	0.003	0.005	0.0057	0.0027	0.002	0.008		
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)								
Temps. (After)								

CP11905

# DATA RECORD

Date 7-10-62 Test Condition Ground Run at  
Time 5:40 P. M. 6400 RPM - Forward and aft  
engine vibration data not  
O.A.T. 28°C reasonable.  
Wind 10 K  
Weather Clear Recorded By T. Corbet  
Time of Run 15 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top	0.033	0.074	0.27	0.40	0.33	0.125	0.05	0.52
XMSN Base	0.019	0.10	0.23	0.23	0.13	0.009	0.063	0.33
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.	0.0001	0.00015	0.0001	0.00015	0.0001	0.0001	0.0001	0.0003
FWD Eng.	0.0001	0.00013	0.0001	0.00015	0.0017	0.00012	0.0002	0.0003
Tail	0.01	0.02	0.02	0.013	0.030	0.05	0.065	0.09
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.	0.004	0.006	0.003	0.0013	0.0002	0.0065		
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)								
Temps. (After)								

CP11505

# DATA RECORD

**Date** 7-11-62 **Test Condition** Ground Run at  
**Time** 11:35 A. M. 6400 RPM - Used Ballantine 310  
for this data.  
**O.A.T.** 32° C  
**Wind** 1 - 2 Knots  
**Weather** Clear and Sunny **Recorded By** T. Corbet  
**Time of Run** 20 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top	0.035	0.07	0.29	0.42	0.31	0.12	0.052	0.50
XMSN Base	0.019	0.095	0.21	0.21	0.11	0.085	0.055	0.29
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.	-----	-----	-----	0.00016	0.00028	-----	0.00011	0.00026
FWD Eng.								0.0003
Tail	0.0075	0.023	0.02	0.011	0.0065	0.02	0.028	0.048
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.	0.006	0.005	0.003	0.0011	0.0002	0.008		
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)	410	410	420	450	450	430	430	170
Temps. (After)	440	500	460	500	510	510	480	170

CP11805

# DATA RECORD

Date 7-11-62 Test Condition Ground Run at  
Time 1:45 P. M. 6400 RPM. Data recorded after  
shielded input lead pins were  
O.A.T. 32° C tinned - Ballantine 310 voltmeter  
Wind 3 Knots, S.E. used for this data.  
Weather \_\_\_\_\_ Recorded By T. Corbet  
Time of Run 15 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top	0.033	0.075	0.28	0.42	0.28	0.11	0.048	0.49
XMSN Base	0.018	0.10	0.22	0.21	0.13	0.13	0.083	0.31
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.	0.013	0.005	0.008	0.028	0.029	0.0085	0.005	0.037
FWD Eng.	0.003	0.0035	0.0048	0.0125	0.015	0.007	0.009	0.021
Tail	0.008	0.023	0.021	0.01	0.006	0.022	0.028	0.048
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.	0.006	0.004	0.0027	0.001	0.00022	0.007		
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)								
Temps. (After)								

CP11805

# DATA RECORD

Date 7-11-62  
Time 2:40 P. M.  
O.A.T. 28°C  
Wind 3 Knots  
Weather \_\_\_\_\_

Test Condition Ground Run at  
6400 RPM - Data recorded from  
Ballantine Model 316. 90° Gear  
Box temperature indication -  
verified by TRECOM pyrometer.  
Recorded By T. Corbet  
Time of Run 20 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top	0.2	0.56	2.1	3.3	2.9	1.25	0.63	4.3
XMSN Base	0.135	0.56	1.35	1.65	1.05	0.95	0.58	2.3
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.	0.047	0.028	0.042	0.105	0.11	0.053	0.042	0.20
FWD Eng.	0.023	0.02	0.028	0.068	0.087	0.052	0.78	0.155
Tail	0.052	0.115	0.115	0.058	0.038	0.115	0.165	0.32
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.	0.027	>.02	>.02	>.02	>.02	0.024		
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)								
Temps. (After)	440	510	490	510	510	510	490	175

CP11806

# DATA RECORD

Date 7-11-62 Test Condition 70 knots straight  
Time 3:20 P. M. and level at 2000 feet - Transmis-  
sion base vibration light indicated  
O.A.T. 28°C when landing - XMSN oil pressure  
Wind 10 K 40 PSI after 33 minute flight.  
Weather \_\_\_\_\_ Recorded By T. Corbet  
Time of Run 20 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top	0.028	0.083	0.25	0.38	0.25	0.092	0.045	0.44
XMSN Base	0.023	0.12	0.23	0.23	0.14	0.11	0.078	0.33
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.	0.016	0.0075	0.0085	0.038	0.058	0.018	0.0058	0.074
FWD Eng.	0.018	0.008	0.0047	0.027	0.037	0.013	0.0095	0.048
Tail	0.013	0.026	0.026	0.013	0.0075	0.018	0.024	0.045
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.	0.005	0.012	0.01	0.0038	0.0004	0.016		
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)								
Temps. (After)	440	490	450	460	480	500	450	170

CP11805

# DATA RECORD

Date 7-11-62 Test Condition Straight and level  
Time 4:28 P. M. 70 knots at 2000 feet altitude.  
O.A.T. 28°C  
Wind 10 Knots  
Weather Clear Recorded By T. Corbet  
Time of Run 15 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top	0.026	0.084	0.26	0.42	0.22	0.09	0.044	0.45
XMSN Base	0.019	0.12	0.20	0.23	0.15	0.14	0.094	0.34
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.	0.023	0.0075	0.0065	0.043	0.064	0.023	0.0065	0.04
FWD Eng.	0.022	0.008	0.0047	0.032	0.047	0.017	0.0095	0.028
Tail	0.017	0.03	0.027	0.012	0.0085	0.016	0.022	0.048
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.	0.0045	0.019	0.012	0.0043	0.0004	0.017		
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)	425	475	440	460	460	470	440	175
Temps. (After)								

CP11809

# DATA RECORD

Date 7-11-62  
 Time 4:45 P. M.  
 O.A.T. 26°C  
 Wind 10 K  
 Weather Clear

Test Condition Hover Out-of-  
ground effect - Transmission chip  
detector indication - Flight aborted  
Measured resistance 40,000 ohms

Recorded By T. Corbet  
 Time of Run 20 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top	0.027	0.11	0.023	0.47	0.27	0.11	0.043	0.45
XMSN Base	0.029	0.13	0.19	0.26	0.15	0.13	0.078	0.33
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.	0.026	0.013	0.008	0.038	0.065	0.023	0.0067	0.07
FWD Eng.	0.023	0.0075	0.0045	0.029	0.047	0.0011	0.0095	0.052
Tail	0.015	0.023	0.023	0.011	0.0067	0.012	0.017	0.043
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.								
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)								
Temps. (After)	440	510	470	490	500	510	460	175

CP11805

# DATA RECORD

Date 7-11-62

Test Condition Hover 15 feet

Time 6:40 P. M.

Aft shaft bearing indication -

Flight aborted - Indication

O.A.T. 32°C

verified by Bell Helicopter

Wind -----

Representative: Thomas Fleming.

Weather Clear

Recorded By T. Corbet

Time of Run 5 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top	0.03	0.01	0.25	0.43	0.26	0.10	0.05	0.49
XMSN Base	0.02	0.11	0.19	0.22	0.15	0.15	0.082	0.30
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.	0.002	0.008	0.006	0.045	0.05	0.022	0.009	0.065
FWD Eng.	0.015	0.004	0.005	0.027	0.032	0.015	0.01	0.042
Tail	0.014	0.027	0.024	0.018	0.006	0.0085	0.017	0.046
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.	0.004	0.008	0.005	0.0015	0.00025	0.01		
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)								
Temps. (After)	425	490	475	500	500	490	450	170

CP11806

# DATA RECORD

Date 6-11-62 Test Condition Climb 500 feet  
Time 7:10 P. M. per minute.  
O.A.T. 28°C  
Wind 10 K  
Weather Clear Recorded By T. Corbet  
Time of Run 5 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top								0.45
XMSN Base								0.33
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.								0.075
FWD Eng.								0.056
Tail								0.038
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.								0.015
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)								
Temps. (After)								

CP11805

# DATA RECORD

Date 7-11-62

Test Condition Autorotation

Time 7:15 P. M.

Temperatures taken after landing  
and shutdown.

O.A.T. 24°C

Wind 10 K

Weather Clear

Recorded By T. Corbet

Time of Run 5 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top								0.43
XMSN Base								0.35
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.								0.031
FWD Eng.								0.015
Tail								0.038
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.								0.005
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)								
Temps. (After)	430	500	470	480	490	510	470	175

CP11808

# DATA RECORD

Date 7-12-62 Test Condition Ground Check  
Time 8:30 A. M. Shut down before completion due  
to lack of fuel.  
O.A.T. 24°C  
Wind Calm  
Weather Cloudy Overcast Recorded By T. Corbet  
Time of Run 10 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	ALL	All
XMSN Top							0.58	0.5
XMSN Base							0.32	0.34
	20-40	40-80	80-160	160-320	320-500	500-1KC	ALL	All
AFT Eng.							0.049	0.045
FWD Eng.							0.029	0.033
Tail							0.040	0.041
	3-6	6-12	12-24	24-50	50-100	All	ALL	ALL
Low Freq.							0.0005	0.0007
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)								
Temps. (After)								

CP11805

# DATA RECORD

Date 7-20-62

Test Condition Straight and level

Time 10:15 A. M.

70 knots.

O.A.T. 28°C

Wind -----

Weather                     

Recorded By T. Corbet

Time of Run 20 minutes

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All
XMSN Top	0.024	0.088	0.27	0.41	0.23	0.084	0.043	0.47
XMSN Base	0.021	0.13	0.24	0.26	0.14	0.10	0.066	0.35
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All
AFT Eng.	0.023	0.009	0.0077	0.042	0.064	0.021	0.0064	0.068
FWD Eng.	7.001	7.001	7.001					0.12
Tail	0.011	0.023	0.025	0.012	0.009	0.018	0.024	0.047
	3-6	6-12	12-24	24-50	50-100	All		
Low Freq.	0.008	0.014	0.01	0.003	7.001	0.02		
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.
Temps. (Before)	440	440	450	460	450	450	450	175
Temps. (After)	430	490	460	460	460	500	450	175

CP11808

# DATA RECORD

Date 7-23-62

Test Condition Ground Run

Time \_\_\_\_\_

XMSN Input Quill Temp. Indication

XMSN Chip Detector Indication

O.A.T. 28°C

Wind W - NW 8 - 10 K

Weather Partly Cloudy

Recorded By T. Corbet

Time of Run 42 minutes

Model  
316  
ALL

Channel	500-1KC	1-2KC	2-4KC	4-8KC	8-12KC	12-16KC	16-20KC	All	
XMSN Top	0.029	0.077	0.30	0.39	0.27	0.10	0.045	0.51	3.7
XMSN Base	0.018	0.10	0.18	0.17	0.18	0.11	0.07	0.27	2.0
	20-40	40-80	80-160	160-320	320-500	500-1KC	1-2KC	All	
AFT Eng.	0.01	0.0065	0.007	0.037	0.042	0.011	0.005	0.049	0.2
FWD Eng.	0.006	0.0047	0.005	0.017	0.019	0.007	0.009	0.024	0.16
Tail	0.009	0.027	0.028	0.012	0.006	0.01	0.017	0.04	0.29
	3-6	6-12	12-24	24-50	50-100	All			
Low Freq.	0.0035	0.0025	0.002	0.001	0.00015	0.005			0.022
	Swash Brg.	Mast Brg.	Fwd Shaft	Mid Shaft	Aft Shaft	42 GB	90 GB	Amb. Temp.	
Temps. (Before)	410	430	430	440	440	430	440	175	
Temps. (After)	430	510	490	510	520	510	460	175	

CP11808

## GRAPHIC DOCUMENTATION

### GENERAL

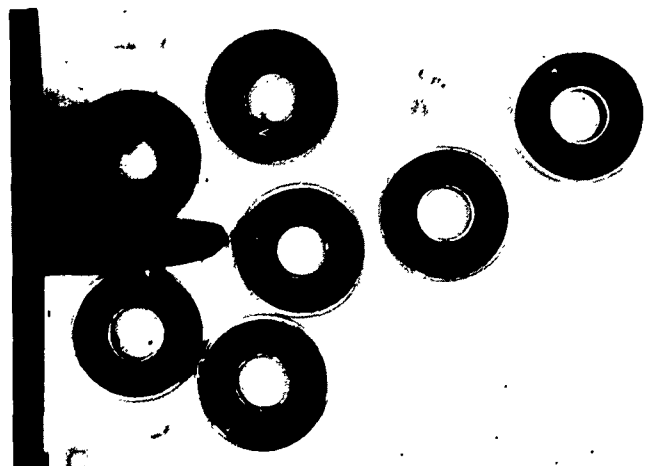
This section contains basic photographic documentation of certain specific component reinstallations. Figure 7 and Figure 8 are photographs showing evidence of accumulation of metal particles in the Engine Oil Filter. This condition was discovered during the process of reinstalling the new-type filter which contained the ALARM sensors.

The engine had been overhauled prior to installation on this particular aircraft and this prompted an investigation by the Lycoming Engine representative to determine the cause(s) of the accumulations. As a result of the investigation, it was determined that the particular engine oil filter (old-type) had not been properly maintained prior to installation in the engine.

Figures 9 through 21 show actual sensor and component installations at various critical points throughout the test-bed aircraft.



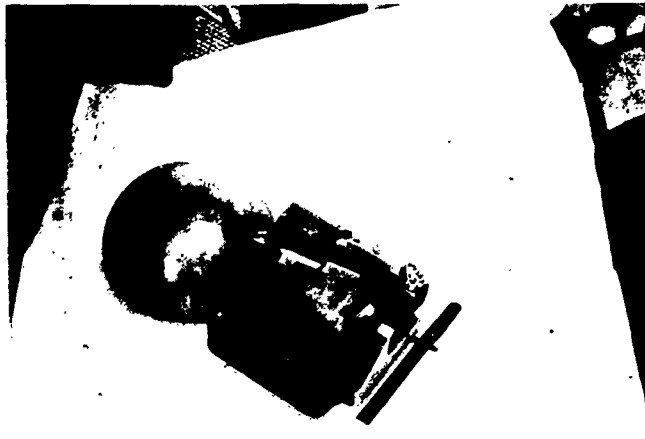
**Figure 7. Engine Oil Filter Bowl (Shows Evidence Of Metallic Particles After Engine Overhaul).**



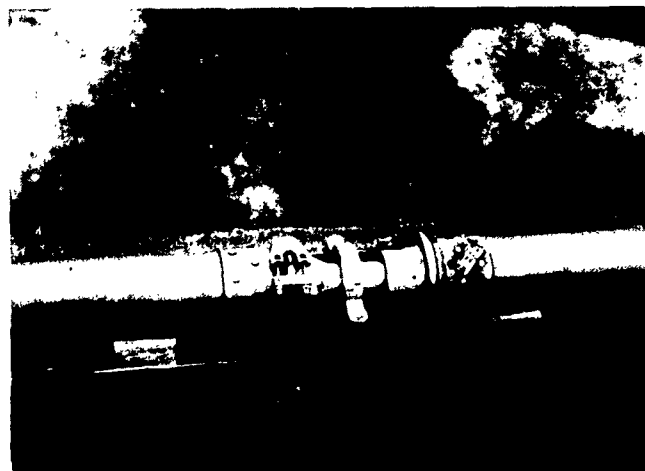
**Figure 8. Engine Oil Filter Screens (Shows evidence Of Metallic Particles After Engine Overhaul).**



**Figure 9. Transmission Bypass Relief Valve (Before Installation).**



**Figure 10. Landing and Searchlight Interlock (Before Installation).**



**Figure 11. Middle Tail Rotor Drive Shaft Hanger Bearing.**



**Figure 12. Feedthru Terminal in Tail Boom Section.**



Figure 13. Low Frequency Vibration Pickup Installation In Forward Communications Compartment.



Figure 14. Engine Oil Flow Meter And Engine Oil Liquid Level Detector Installation.

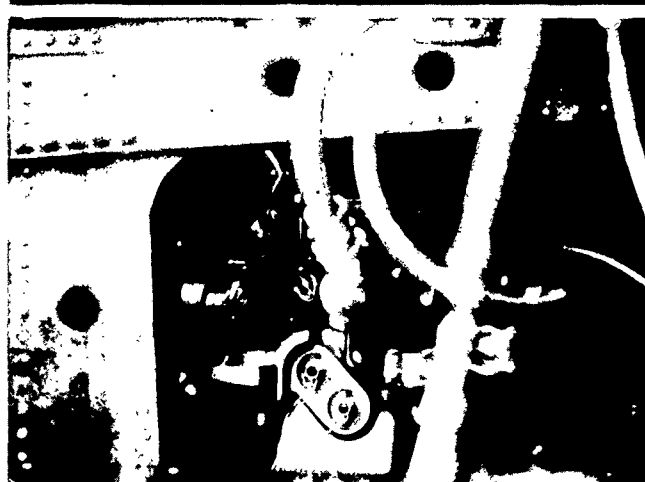
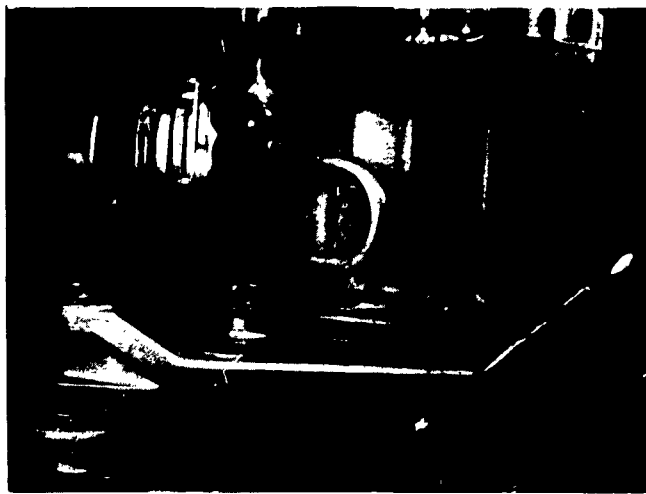


Figure 15. Transmission Oil Level Detectors And Oil Filter Installation.



**Figure 16. Transmission Oil  
Cap Security Interlock And  
Transmission Input Quill  
Thermal Ribbon Installation.**



**Figure 17. Engine Oil Filter,  
Forward Engine Vibration  
Pickup And Engine Oil Magnetic  
Chip Detector Installation.**



**Figure 18. Aft Engine Vibration  
Pickup Installation.**

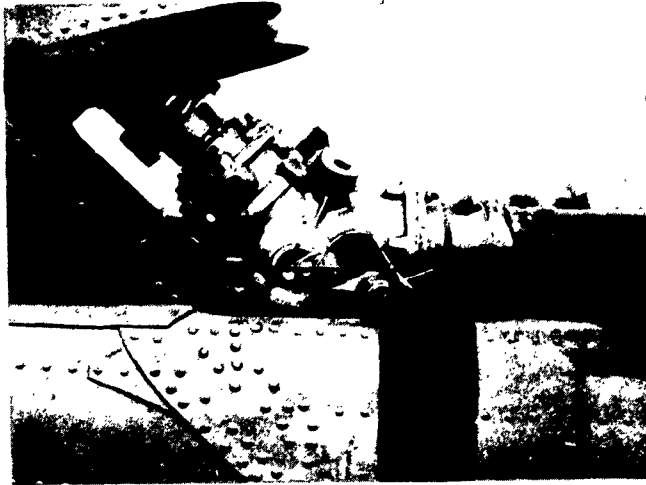


Figure 19. Liquid Level Detectors, Thermal Ribbon And Magnetic Chip Detector Installation In 42° Gear Box.



Figure 20. Liquid Level Detectors, Thermal Ribbon And Magnetic Chip Detector Installation In 90° Gear Box.

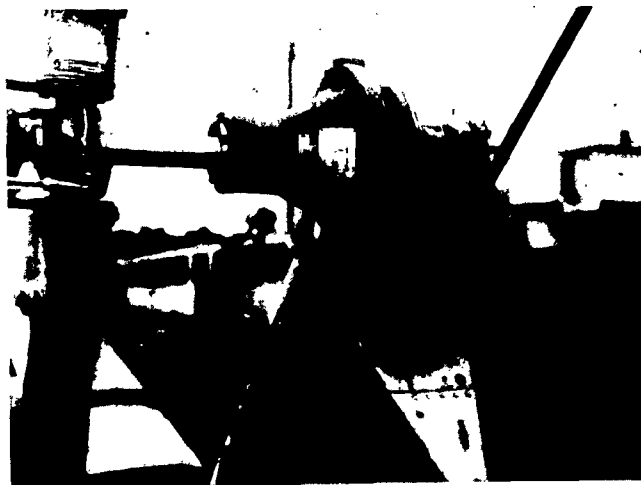


Figure 21. Tail Vibration Pickup, Magnetic Chip Detector, Liquid Level Detector And Thermal Ribbon Installation In 90° Gear Box.